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Engineering News-Record

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Design of the Detroit River Suspension Bridge

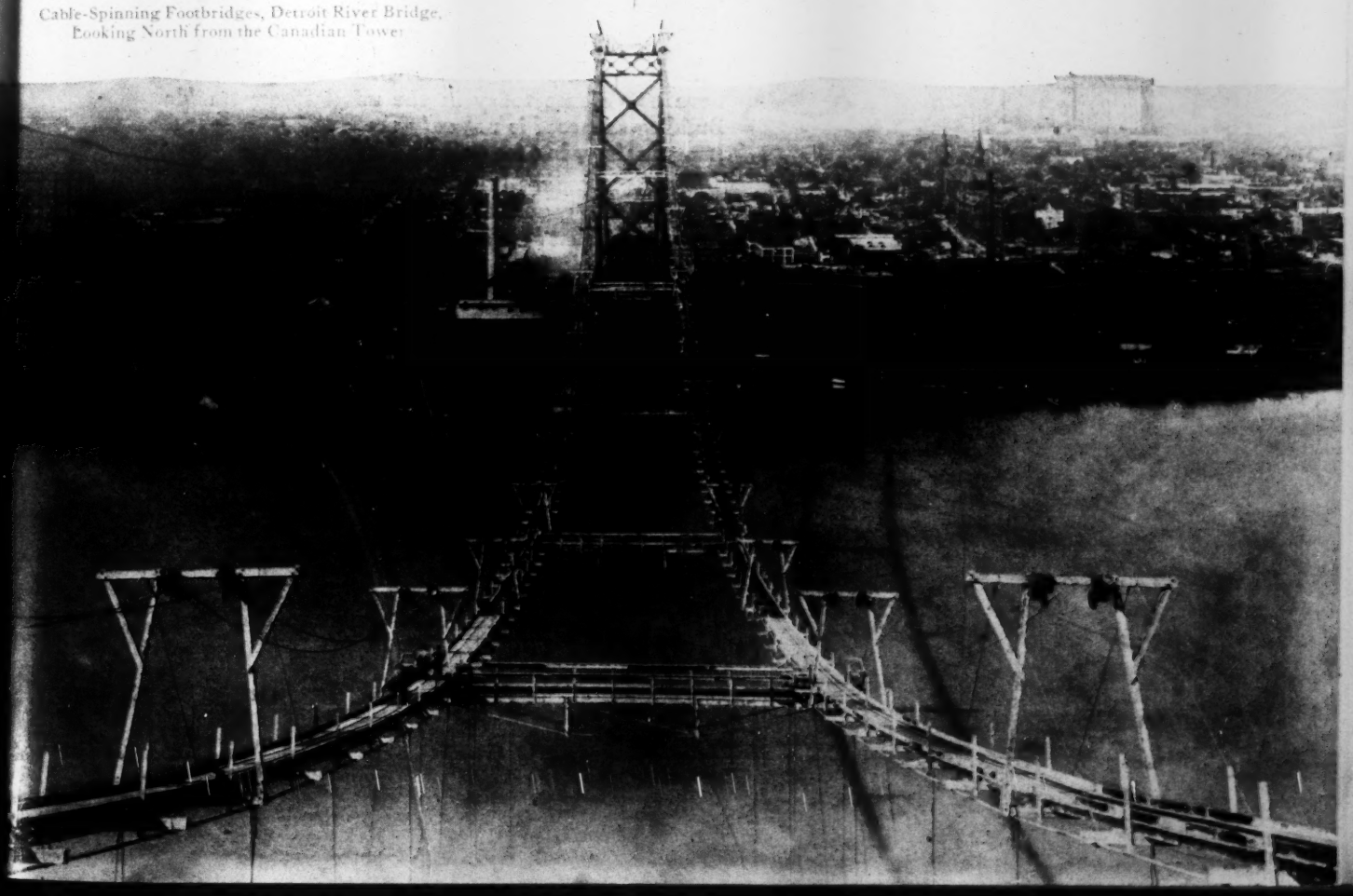
Relation Between Output and Cost in Concrete Mixing

Activated Sludge Plant Produces Fertilizer at Pasadena

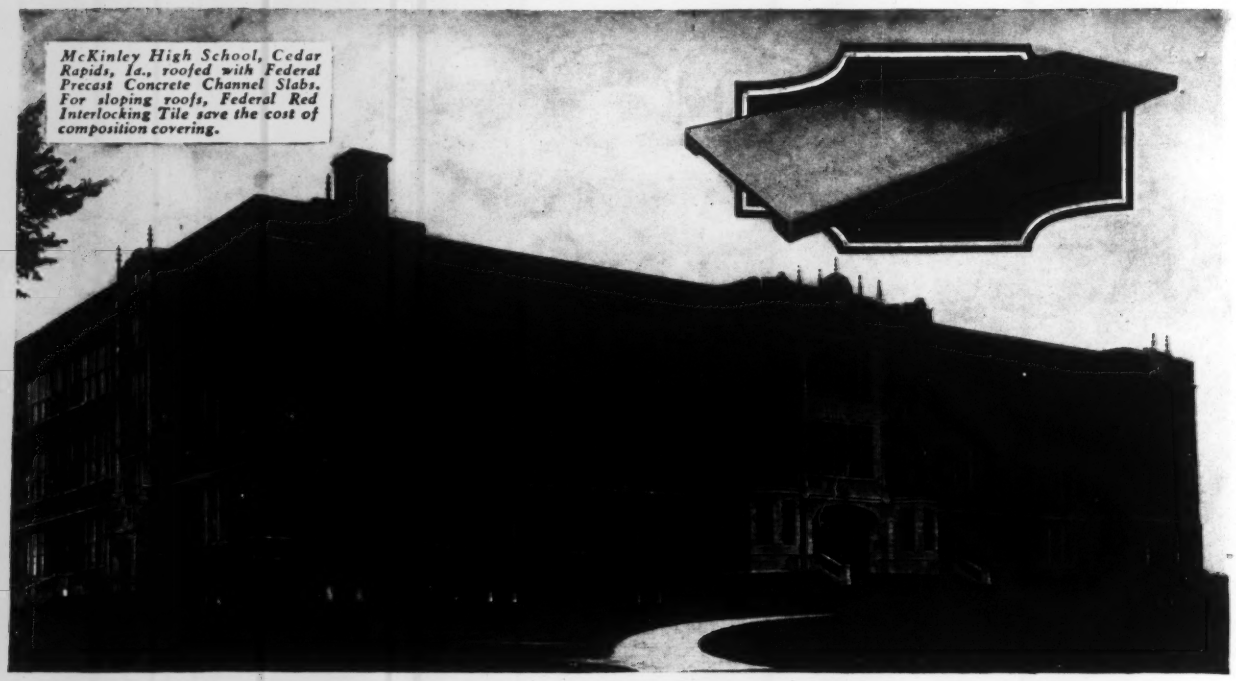
Revamping a Steel Viaduct at Topeka, Kansas

Fast Concrete Road Building Under Rush Orders

Report of the New England Water Works Association Meeting



Cable-Spinning Footbridges, Detroit River Bridge, Looking North from the Canadian Tower



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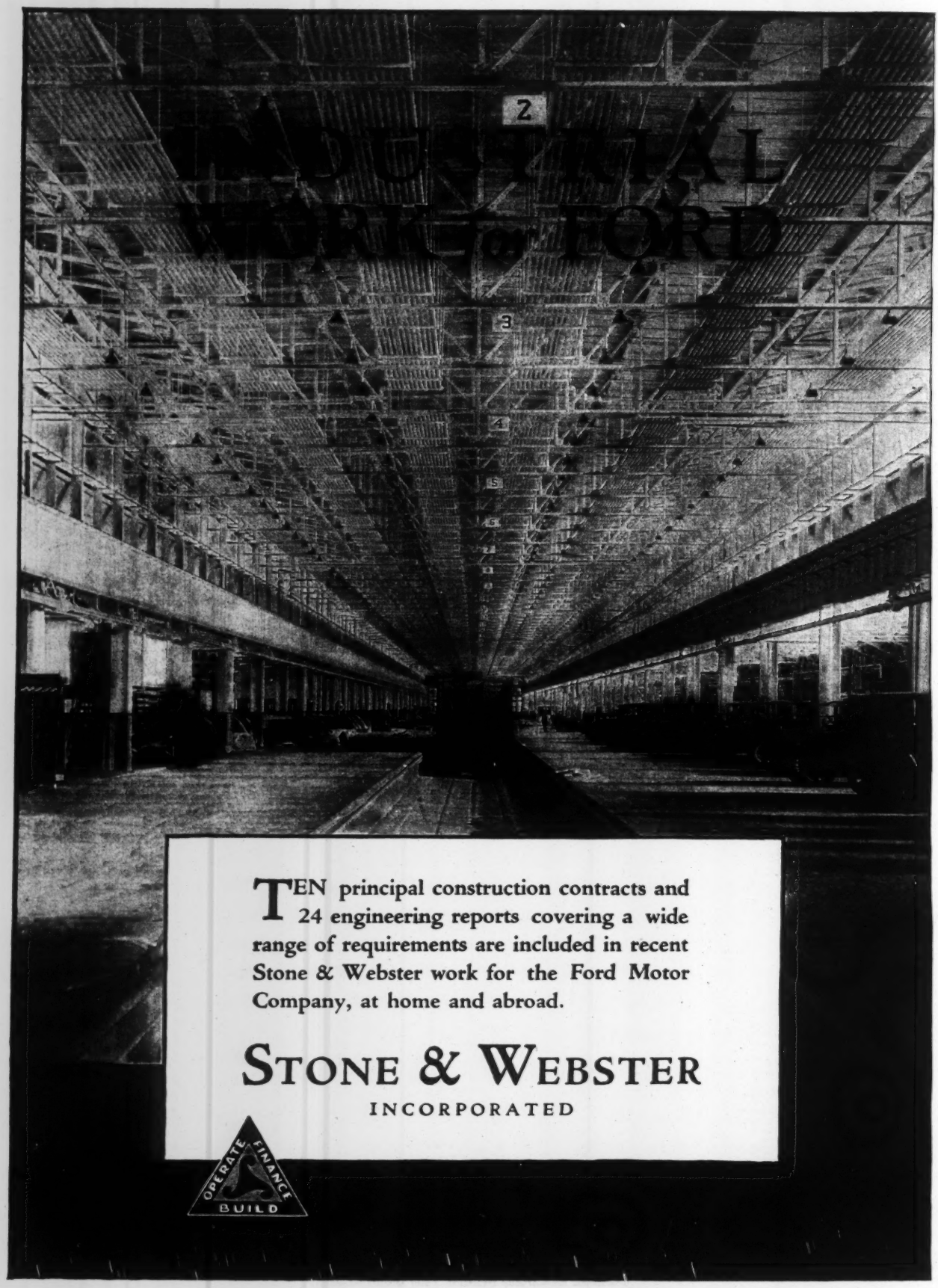

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Volume 101 NEW YORK, SEPTEMBER 27, 1928 Number 13

Unstable Earth

SENSATIONAL emphasis is laid on the imperfections of present knowledge relating to the stability of earth masses by the startling news that a high rolled-fill earth dam under construction was disrupted by extensive slumping. Before this, uncompleted dam embankments have slumped in a number of notable cases, the best remembered being Calaveras and Necaxa; but these were of the hydraulic type, which carried within them the ever-present threat of soft and highly plastic masses of supersaturated clay. Slips have happened in other embankments, both completed and uncompleted, when impounded water was drawn down, as at Wachusett. But rolled-fill embankments not complicated by impounded water have always been among the most stable and dependable of human works in earth. So at the Lafayette dam: The observations reported in Dr. Bowers' account show that the embankment had all the stability that is normally expected of well-graded soil concrete. The conclusion suggests itself that something happened below the foundation of the dam and that the embankment above was disrupted thereby. At Oakland, not far away, land slips have given much trouble in the past, and tendencies to such instability are often characteristic of a whole countryside that is geologically and topographically alike. The possibility of a foundation earth slip or flow is a notable development in the art of building earth dams. If full investigation shows it to be the cause, the study of foundation conditions in unconsolidated ground will often need to be much more elaborate than heretofore and take quite different direction. On the other hand, if the slipping originated in the rolled fill itself, future investigation of the stability of embankments will need to be based on new concepts.

Hurricane Repetition

AS REPORTS gather from last week's hurricane swath through Florida, a picture of startling violence of the elements is unfolded. Though comparisons are uncertain, the indications are that velocity and pressure of the wind were substantially as great as in the Miami hurricane of two years ago. Fewer large structures were in the storm area, but the effect on minor structures, such as dwelling houses, fully warrants assigning both storms to the same order of intensity. Until now it seemed that these exceptional visitations of great destructive power of the wind occurred but rarely in any one region, at least of the United States; now, however, the speedy repetition of the Miami devastation in an immediately adjoining region gives unmistakable warning that great storm forces may occur frequently and must be taken into account in the construction of human works. Velocities of 150 m.p.h. have been estimated for Palm Beach, and in view of the practical certainty that such velocities occurred in the Miami storm and the close similarity of their effects it may be considered likely that they were attained at Palm Beach also. Taking into account the intensifying effect of heavy rain driven at the same speed—a factor absent from laboratory and wind-tunnel measurements—there can be little doubt that pressures of 50 to 75 lb. per sq.ft. are exerted upon many objects in such a storm area. It is true that, because of the failure of scientific study, the time factor is not known: the duration of the maximum pressures and the manner of their repetition. It is also true that variations of pressure are likely to diminish the effect below the maximum; but, on the other hand, they may increase it, by their periodic effect. Hitherto general structural design has not recognized the need of considering forces of such great magnitude. In the face of the Palm Beach hurricane, it is difficult to see how this recognition can be long avoided.

Okeechobee's Storm Waves

IN BOTH human and engineering aspects the structural effects of the Palm Beach hurricane, great as they are, sink into insignificance compared with the disastrous flood which it produced along the southeast edge of Lake Okeechobee. Here the lake overwhelmed its shore region in a great storm-driven wave, drowning as yet uncounted hundreds—a precise repetition of the destruction of Moorehaven in the Miami storm of 1926 except that this time another corner of the lake is involved and the number of victims is far greater. On both occasions the flood wave rose 8 to 10 ft., far over the levee tops, and covered the partly reclaimed marsh lands sloping down away from the lake to a depth of many feet. Few human beings within the range of either flood escaped. It is appalling to think that such a disaster could be repeated so soon. The tragedy makes it clear that complete restudy of the great problem of controlling Lake Okeechobee, the key problem of the Everglades reclamation, is at once necessary. Human settlement along the low shores of the southerly half of the lake is impossible until they are rendered safe against storm wave overflow. It would seem from the present facts of the situation, in view of the narrowly limited range of water level and the great inflow volume from the Kissimmee River, that only high levees can give this protection. But so little is known of the possibilities of storm-driven waves and their actions that this conclusion is merely inferential. The problem of central Florida remains, as it has long been, one of the great challenges to the civil engineer's skill and the statesman's directing power.

Speedy Highway Building

BUILDING 10.4 miles of Texas highway in 70 days, as described in this issue, puts road construction on a plane with modern bridge and building construction for speed. The extensive use of modern equipment and well-planned methods made a fast construction schedule possible. The concrete slab was poured in 42½ days—at a maintained rate of 1,170 ft. per day. But of more impor-

tance to the roadbuilding industry than the speed attained in construction is the innovation of placing a concrete slab on a freshly made fill. Such procedure is so at odds with current practice that it is worthy of consideration. Outside of a swamp crossing the grading was fairly light. The fills, while low (1 to 4 ft. high) were carefully prepared, and rolled while wet. Inspection by test holes assured that the subgrade was solid. A standard concrete slab with thickened edges and mesh reinforcing was used. Time will be required to determine the success of this method, but it is clear that if the road proves durable after a fair test of traffic and weather a worthy precedent will have been established. Since highway construction is always a source of inconvenience to residents and travelers in a community, methods and practices tending to lessen the actual building time required will be of real public value. Early completion on this particular job was demanded by a special occasion. But why not speed up the regular highway job, if fast work is known to be possible?

Catching Up With the Times

FORTY miles an hour is the permissible road speed of motor traffic in New Jersey under a new law which has just gone into effect. The speed limit hitherto was 30 miles an hour, as it still is in some states under laws that have long become a dead letter. In following the lead of some more progressive states and recognizing the hard facts of modern traffic needs—facts which even most traffic enforcement officers recognize as being more imperative than the dead-letter law—New Jersey is catching up with the times in an important matter. It is also increasing the safety of life and property by the change. Observation shows that the existence of a 30-mile maximum limit in a 40-mile age promotes accidents rather than safety. To generalize somewhat more broadly, it may be said that all of our governments have been uncomfortably backward in bringing and keeping their traffic laws up to date and that this very legislative neglect has played a large part in the growing up of traffic vices and danger conditions. But within the last year or two the pressure of traffic problems has become pronounced enough to overcome even the inertia and fearfulness of legislative bodies. We may look forward to a time of more or less general revision of traffic regulations and practices, with distinct gain in safety and transportation efficiency.

Uniform Traffic Control

THE chaotic state of traffic handling in cities and towns has come to be the most burdensome feature of travel. In conjunction with its modernization of speed restrictions, New Jersey has taken steps to simplify and unify state-wide traffic control in a revised traffic code. Most of our existing traffic laws, necessary as they are, resulted from the illogical application of customs and habits of a bygone age to our modern life. As the hitching posts disappeared from the public squares, each community found its long-dormant and peaceful vehicular traffic suddenly seized with growing pains, and thereupon it sought immediately to restrict and control that new situation by its own individual notions and methods. With increased traffic density on streets and highways the communities enacted more laws, often haphazard and inefficient, in an attempt to cope with the rapidly growing congestion and danger to public safety. But in a few short years highway traffic was no longer a local problem—it had become intrastate and interstate. No matter how efficient the control imposed by any one town, city or county, the differences in their methods of control caused confusion and congestion. Such is the situation today in many states. A uniform-control law such as the new code of New Jersey is the necessary cure of the evil. Speeds, signal lights and pedestrian control have been made uniform throughout the state and local governments are forbidden to change the rules except in special cases of congestion. Our highway systems have lagged behind in taking care of increasing traffic. Until we can provide highway layouts and structures adequate to the existing and future needs of vehicular movement, uniformity in control will do much to handle a difficult situation. Other states can well afford to watch the result of New Jersey's attempt to provide traffic relief.

Mixer Standardization

A LONG struggle to obtain mixer simplification seems to be approaching success. Official announcement has been made by the Pennsylvania highway department that hereafter all paving mixers used on state road work will be rated according to the published schedule of the Mixer Manufacturers Bureau of the Associated General Contractors, and that no pavers will be approved which do not have attached the standard A.G.C. rating plate. Other state highway departments have the same requirements virtually in force. The highway engineer thus is taking active steps to uphold the hands of the contractor and the manufacturer in an important piece of progress.

This development in mixer standardization forecasts the long course that will have to be pursued in other hoped-for simplifications of equipment. Agreement on standards by the manufacturers and official indorsement of these standards by the contractors' associations have to be supplemented by the requirement on the part of engineers that only standard equipment shall be employed.

An equally important fact to be observed is that in this mixer simplification the standardization extends only to capacity rating of mixers and their designation according to this rating, and to the number of sizes (capacities) of mixers that will be regularly manufactured. There is no restriction of drum shapes, of the manner of charging or discharging, of mixing action, of construction materials, of driving motors or of any other mechanical detail. The inventor, designer or maker may exercise his will, or even his whim, in all things except capacity rating and number of sizes produced. Indeed, he can build to order any odd size, arrangement or mounting of mixer that any special customer may wish.

This is in accordance with the fundamental doctrine of construction equipment standardization as it is now being proposed for extension. It is a doctrine that is not well enough understood. There persists a fear by designers and builders of machines for construction that in consenting to standardization they must agree to restrictions on their inventiveness and on their merchandising enterprise. This is unwarranted. Were it not, standardization would kill all that goes to create improvement in the equipment manufacturing business. Instead, standardization as it is now being urged promotes invention and increases selling enterprise by centering on those activities the attention which otherwise would be devoted to devising tricks in capacity ratings and to producing odd sizes for no better purpose than to outreach com-

petitors or to satisfy the whim of some few purchasers.

The experience with mixers furnishes a lesson which manufacturers can study with profit. Through intelligent standardization the mixer manufacturers have saved money in production, have transmitted some of that saving to their customers and have increased their business. There has been no time when merchandising enterprise has been keener or when greater effort has been centered on mechanical and constructional improvement.

A Supension Bridge Era

UNUSUAL significance attaches to the first bridge over the Detroit River, described in this issue. It is the first bridge across the international waters in the Detroit region, hitherto crossed only by two railway tunnels. It affords a connecting link in a new international east-west highway. It adds another major toll highway structure to a growing list. And for the time being is the longest suspension structure yet built.

That the Detroit bridge is of the suspension type is the more significant because of the revival of moderate-span suspension construction in the Ohio River Valley after a lull of two decades, no less than four such structures of approximately 700-ft. span being in various stages of completion. Add to these the great Hudson River bridge of 3,500-ft. span at New York City, the Mid-Hudson bridge of 1,500-ft. span at Poughkeepsie, N. Y., and the Mount Hope bridge of 1,200-ft. span near Providence, R. I., and the list of current suspension-bridge projects becomes unusually impressive.

What does this activity presage for the science of suspension-bridge engineering? Until recently it was generally conceded that no change in the broad conceptions of suspension-bridge design had occurred in the last quarter-century. Certain it is, however, that no field of engineering can enjoy unusual activity and not profit by it to some extent. The result of the manner in which simple-span bridge construction was pushed ahead by the railroads is a classic example. A more modern one occurs in the highway field of today.

A period of intense suspension-bridge construction will first of all afford welcome opportunity to test some of the many designs and construction theories that are in danger of gathering dust and mold from lack of use. From the time that Roebling crowned his suspension-bridge achievements with the Brooklyn bridge and Rankine expounded his original theory of the stiffening truss, the engineering profession has been deluged with currents and countercurrents of theory. Vastly more opinionated discussion than bridges has resulted. Europe has contributed much to the discussion and produced no major structures. America has done better, but can exhibit only the Manhattan and Williamsburg bridges in New York City, the Bear Mountain bridge over the Hudson, the Philadelphia-Camden bridge over the Delaware and some dozen structures in the Ohio River Valley, most of which were constructed prior to 1905 and are defective in many details. New suspension bridges will give the profession more practical experience. And no science is complete unless it is both empirical and theoretical.

That progress is being made at least in structural details has been apparent in every suspension structure that has been undertaken in recent years. On the Bear Mountain bridge a method of placing the cables outside the stiffening trusses by suspending the cross-girder supports from the hanger rods was an important innovation in design. The Florianopolis bridge in Brazil proved the success of heat-treated eyebar chains, and the close competitive bidding of such eyebars and wire cables on the Hudson River bridge only hastened the development of heat-treated cable wire which is being used at Mount Hope and Detroit. The Philadelphia-Camden bridge introduced two-cable construction for long spans and equipment for wrapping cables 50 per cent larger than any then built. The Delaware River bridge also made outstanding use of alloy steels with a resultant economy in weight and an increased flexibility. Finally, at Mount Hope and at Detroit a new method of spinning the cables in the saddles is to be used which is said to represent the first change in spinning methods in 50 years.

Modern highway development has created the need for moderate- and long-span bridges. A new business philosophy in the matter of toll-refunding financing for bridges has made the structures possible. Whether the arch, cantilever or suspension type eventually predominates, the period from 1925 to 1930 can be set down as a suspension-bridge era. And with the completion of each new structure we can be certain that the art of suspension-bridge engineering approaches in efficiency the other branches of bridge engineering.

Growth of the Safety Movement

THE phenomenal and widespread growth of the movement to promote public and industrial safety is evidenced by the magnitude of the seventeenth Annual Safety Congress, to be held next week in New York City. More than 30 accident-prevention groups representing every great employing industry will meet in one great convention holding sessions in five hotels. More than 6,000 delegates are expected and 325 speakers will address 110 meetings. No single individual, corporation or industry alone will benefit by the convention—but the results will be far-reaching, even though intangible. The entire remarkable progress is the story of the growth of an idea—an intellectual or perhaps emotional germ—rather than of an economic force.

Such a convention is far removed from the humble origin of the safety movement, started some 25 years ago by the "safety first" movement on a Western railroad. This safety idea, quickly taken up by other railroads, represented an inspiringly successful effort to eliminate needless hazards by studied attention and group co-operation. Other industries in time responded to the idea, and its progress since has been steadily forward.

Large contributions to effective safety have been made by state industrial boards, formed to remedy unhealthful and hazardous conditions in industries; labor organizations have helped to improve working conditions bearing on safety; and employers have become ever more conscious of their part in the movement. The extensive safety departments of many large corporations evidence the vitality of the thinking devoted to the subject.

The construction industry, one of the newer recruits to the ranks of those promoting the safety idea, has its main contributions yet to make. Thorough incorporation of safety in construction work is an accomplishment still to be achieved. Many organizations, such as the A.G.C., have done and are continuing to do much to educate the industry in the ways of safety in construction. The work to be done by the construction section at the coming convention will undoubtedly give these efforts further impetus. The general cause of the safety movement, it is certain, will find itself another step ahead.

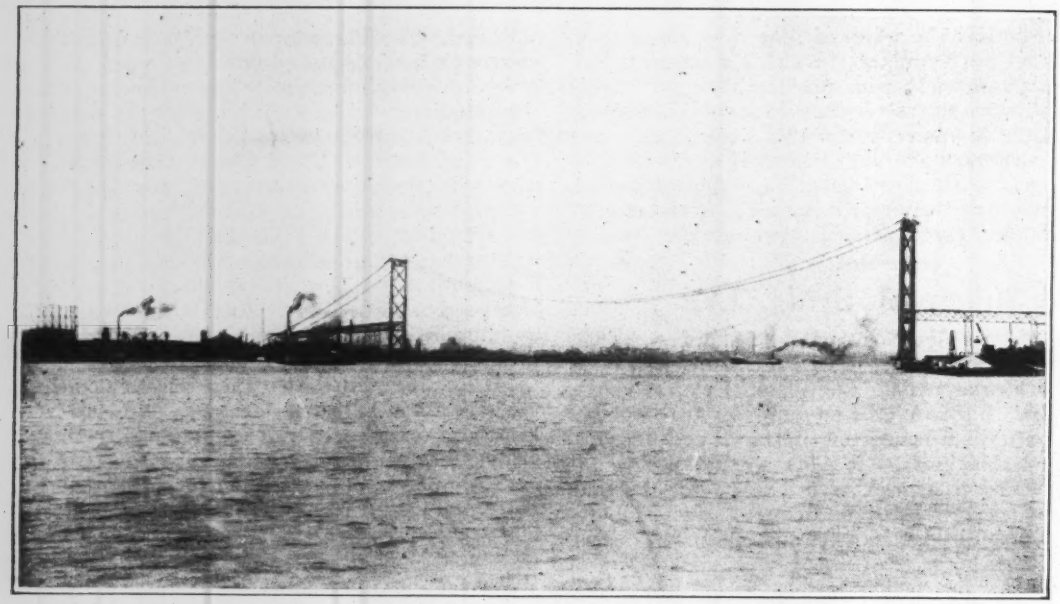


Fig. 1—International Suspension Bridge. Detroit in the Background

Design of Great International Suspension Bridge Over Detroit River

Unusual Anchorages—Unloaded Backstays on 1,850-Ft. Span—Towers, Lacking Full-Height Stability Before Placing Cables, Are Braced by Approach

By Jonathan Jones
Assistant Chief Engineer, McClintic-Marshall Company, Pittsburgh, Pa.

The Detroit River toll bridge now under construction between Detroit and the Canadian shore has passed through a number of stages in both its financial and its technical phases. Originally it was promoted by the American Transit Company, of which Charles Evan Fowler was chief engineer, which determined on the present location and had complete design plans made for a combined railway and highway structure. Finding itself unable to finance the project, this company finally turned it over in 1923 to the Detroit International Bridge Company and the Canadian Transit Company, the interests which are now building the bridge. The original location was accepted as the best available, but all consideration of railway tracks was eliminated and numerous changes in the design were made, particularly in the anchorages, the main towers and the roadway layout. The bridge upon completion will be known as the "Ambassador bridge." Subcontracts for the main piers and anchorage substructures were signed on Sept. 20, 1927, one month and three days after the general bridge construction contracts went into effect. The main piers were ready to receive steel on Feb. 16 and April 2 on the United States and Canadian sides, respectively. This article covers the design considerations of the structure as it is now being built. Numerous special and difficult problems have arisen in the construction, particularly in the foundation work, and these will be treated in a separate article or articles. —Editor.

THE INTERNATIONAL BRIDGE being constructed between Detroit and the "border cities" of Canada is approximately 7,400 ft. long between abutments, and beyond the abutments lie two terminals or plazas each roughly equivalent to a city block in area, so that the distance traveled from entrance to exit is approximately 9,000 ft. The main span, of wire cable suspension type with unloaded backstays, is 1,850 ft. center to center of main piers, which is 100 ft. longer than the Philadelphia-Camden span. The new bridge will be the longest suspension structure and the longest highway bridge in existence until the completion of the Hudson River bridge in 1931. Features of the project are the unusual and costly anchorages, the slenderness of the main towers, the attachment of gussets to floor beams in the shop to facilitate erection and the provision for picking the unloaded backstay cable up to nearly straight during erection.

The roadway is 47 ft. wide and runs generally north and south. There is a single 8-ft. sidewalk along the west side. The 47-ft. roadway affords five traffic lanes and will therefore accommodate three lanes in one direction and two in the other, of the maximum type of automotive vehicle likely to develop. Provision will be made for so directing traffic that three lanes will always be available in the direction of heaviest movement.

According to government requirements, the clearance over recorded high water in the river will be 135 ft. near the shore and 152 ft. for a short distance in the center, making provision for the passage of vessels 20 ft. higher than any that are now plying on the lakes. The center clearance was required because of a similar clearance under the St. Lawrence bridge at Quebec. The maximum approach grade is 5 per cent for a distance of approximately 1,000 ft.

Main Piers—The Canadian main pier is located in 8 to 15 ft. of water, immediately within the harbor line, while the United States main pier is more than 70 ft. inside the harbor line in order to avoid interference with an existing slip and track. Conditions at the two sites are substantially alike, blue clay predominating to about half the depth, underlain by a deep layer of sand and about 12 ft. of hardpan or clay and boulders, limestone bedrock being finally reached at about 105 ft. depth below river level. Core borings were taken 20 ft. (at the anchorage sites 70 ft.) into this rock to prove its soundness.

Each pier carries about 20,000 tons and consists of two hollow, cylindrical, concrete caissons with 10-ft. walls and 18-ft. shaft, making the exterior diameter 38 ft., or about one-third the height. The caissons forming a pair are capped off below water and joined with a concrete strut above which two solid concrete cylinders 29 ft. in diameter complete the pier as shown in Fig. 3. Reinforcement is generous, but no stresses in steel are an element of the design. The Canadian pier is granite faced where exposed to ice action.

Anchorages—Because of the depth to rock and the difficult material to be penetrated (substantially the same as above recited for the main piers) the anchorages are necessarily an item of great cost, so much so that they are one of the primary reasons for adopting unloaded backstay cables to deliver the cable pulls to the anchor grillages reasonably near the ground, rather than loaded backstays which would have made this delivery much higher in the air, whatever expedient might have been adopted to take the forces thence to rock.

Earlier designs contemplated an articulated form of anchorage, in which the pull of each backstay cable would have been resolved, near the ground line, into two components: (1) A rear or tension component carried by eyebars in an inclined concrete tunnel to rock and thence into the rock for direct anchorage without resort to weight; and (2) a forward or compression component carried by a reinforced-concrete shaft (more probably a steel column with concrete protection) similarly carried to a bearing on bedrock. The apparent economy of this design lay in the spread thus obtained between the rear and the forward leg, which reduced the intensity of the stress in each, and in the elimination of great mass as a factor in stability. However, this design was abandoned after the core borings revealed that the bedrock was seamy and carried water under a head of as much as 110 ft., and after it was realized that the effectual exclusion of this water from the anchorage steel involved uncertainties.

FIG. 2—THE DETROIT RIVER BRIDGE CLOSES A GAP IN A NEW EAST-WEST HIGHWAY THROUGH CANADA

The tentative design then resolved itself into a vertical force to be supplied by mass concrete with some assistance from the approach superstructure, and a forward or compression component carried by the steel and concrete strut which would necessarily be of practically twice the originally intended size. On developing this principle in detail, it proved difficult to provide in this inclined strut for the fluctuating line of stress due to changes in live-load stress in the cable. Furthermore, however economical in material this inclined strut might be, it had no precedent in construction, and the net opinion was that it would pay in speed of completion to use more material in a more usual type of construction.

In the plan issued for subcontract bids, therefore, the four inclined struts (one at each end of each cable) are replaced by rectangular caissons, which could be conceived of as the same inclined struts plus sufficient excess material to give the rectangular form and allow vertical instead of inclined sinking. The vertical weight is supplied by mass concrete kept, for economy, above the groundwater line. Sufficient weight is included in the substructure subcontract to permit erection of the cables at the earliest possible moment. The remainder of the mass concrete, all of which will be above street level, is being developed under architectural guidance and will be placed after the cable-stringing operation is completed and the equipment therefor removed and before the suspended structure weight demands it.

Each anchorage substructure, then, comprises two elements: (1) A pair of vertical caissons centered under the cables 22½ ft. in transverse width, 100 ft. in length parallel to the bridge cables and sunk to and into bedrock at depths of about 100 ft. below river level: (2) a cross-

COMPARISON WITH OTHER SUSPENSION BRIDGES

Bridge	Brooklyn	Williamsburg	Manhattan	Bear Mountain	Philadelphia-Camden	Detroit International
Year built	1882	1903	1907	1924	1926	1927
Main span, ft	1,595	1,600	1,470	1,632	1,750	1,850
Side spans carried by	Cables	Columns	Cables	Columns	Cables	Columns
Number of cables	4	4	4	2	2	2
Wires per cable	5,458	7,696	9,472	7,252	18,666	7,622*
Roadway width, ft	2@17	2@20	1@35 1@23	1@38	1@57	1@47
Transit tracks	2	6	8	0	4	0
Sidewalks and width, ft.	1@15	2@17	2@12	2@5	2@10	1@8
Height of main towers, ft.	272	302	291	350	397	363
Mid-span height over water, ft	135	135	135	153	135	152

*First use of heat-treated wire with higher elastic limits.

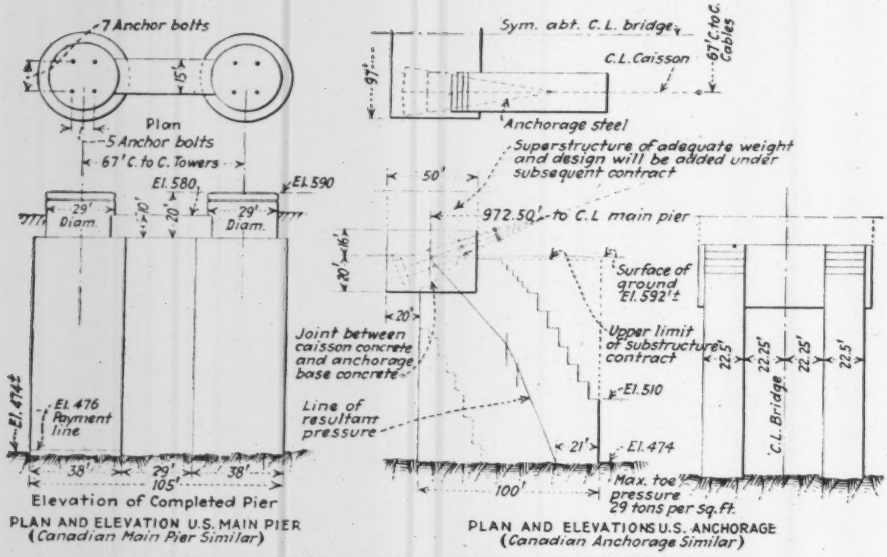


FIG. 3—DETAILS OF MAIN PIERS AND ANCHORAGES

block of concrete 50 ft. from front to rear, 36 ft. deep and 97 ft. transversely, with provision in it for embedment of the anchorage eyebars and grillage, placed above

and spanning transversely across the rear ends of the pair of caissons. In this design no account whatever is taken of resistance from the surrounding ground or of stress in the caisson reinforcement, both of these being reserve additions to the stability.

Approaches—Due to the use of unloaded backstay cables, the distance from main piers to anchorages is traversed by deck spans. On the Canadian side this distance is 798 ft., being the economical distance with equal cable angles at the top of the main towers, and is divided into five 152-ft. spans with a 38-ft. bracing tower. On the United States side, interference from the engine houses of the Pere Marquette, Wabash and Pennsylvania railroads forces the anchorage north to a distance of 953 ft., which interval is divided with reference to tracks and other interferences into six spans

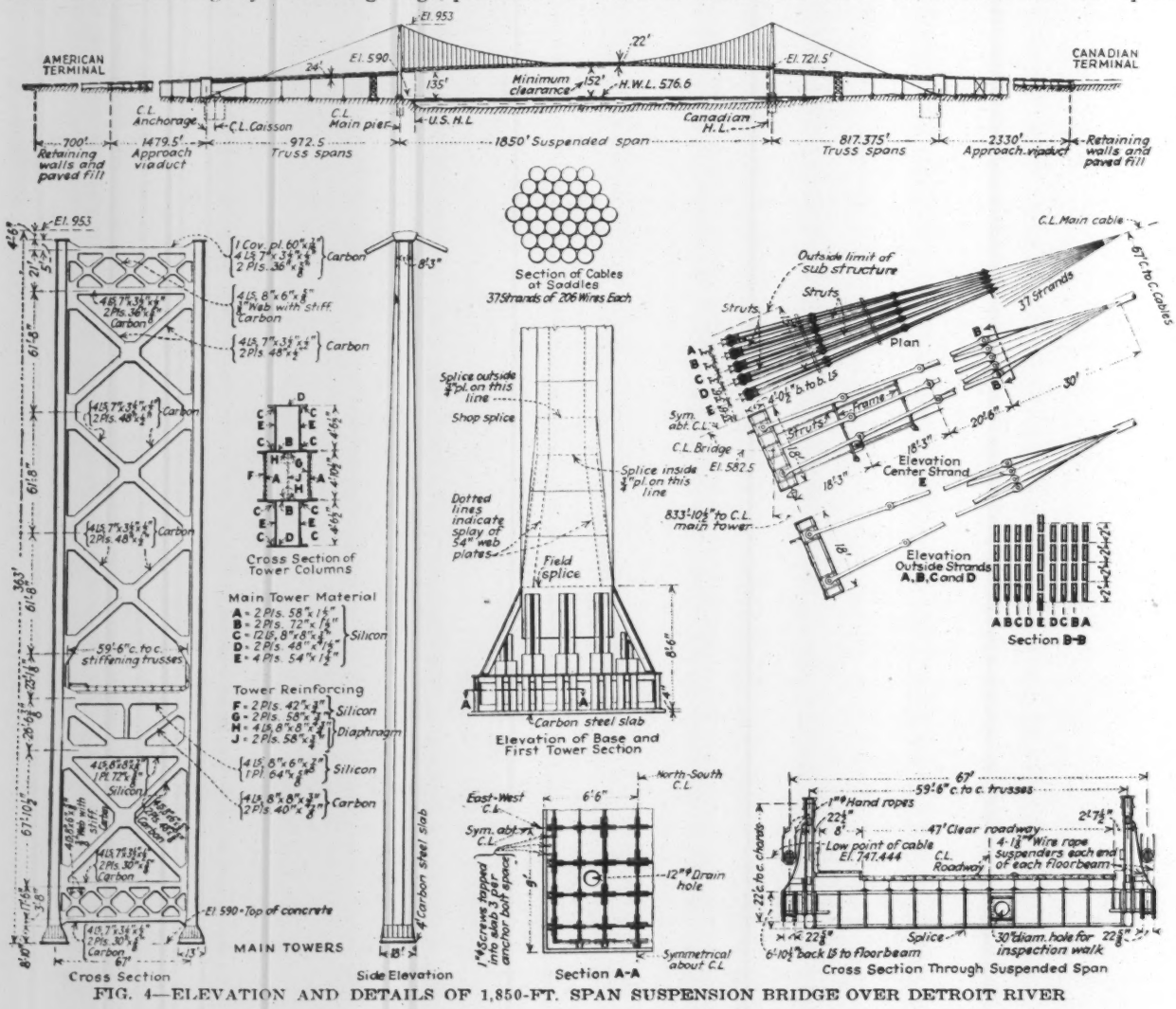


FIG. 4—ELEVATION AND DETAILS OF 1,850-FT. SPAN SUSPENSION BRIDGE OVER DETROIT RIVER

varying from 121 ft. to 196 ft., with a 26-ft. bracing tower.

From the anchorages to the respective terminals the typical construction is a viaduct comprising four rows of plate girders with corresponding four-column bents. On the United States side the steel bents will be replaced at two boulevard crossings by tall piers of mass step-back concrete recalling the architecture of the anchorage superstructure.

In the approaches, instead of longitudinal stringers as used on the main span, transverse floor joists are used, spaced quite uniformly 6 ft. on centers except where curves make this impossible. These joists are considerably cantilevered to reduce the necessary width of the supporting structure. Throughout the viaduct approaches the joists are supported on four lines of plate girders, spaced 14 ft. center to center, or 42 ft. between outer girders. Throughout the truss spans, the inner girders are replaced by 27-in. Carnegie beam stringers, fabricated in two-panel lengths; the outer pair of girders are correspondingly replaced by trusses, the spacing of which increases to 45 ft. Throughout the truss spans and the approach viaducts the number of braced towers is kept to a practical minimum for appearance sake; and the intermediate bents are designed not to rock but to flex with changes in temperature.

Due to long stretches of 5 per cent grade on the United States truss spans and approach, it has been decided to use smooth-dressed granite block from the United States main tower to the terminal, while on the Canadian side the lesser rate of grade permits the use of asphalt.

Main Span—Comparison was made between the suspension and cantilever types, the arch being wholly impracticable. Due to the cost of the anchorages, the difference indicated in favor of the suspension type was less than would be normal for so great a span, though it should be admitted that the factors of uncertainty in such preliminary estimates undoubtedly favored the cantilever and that the actual comparative economy of the suspension is greater than was then computed. The factors of hazard and time, especially the latter, also pointed definitely to the suspension type.

Certain limitations as to size and type of structure are placed upon the contractor, but the contract is in general broad in recognizing that the general contractor is also the designing engineer; and it affords latitude for changes as the details are worked out, such changes being subject to review by the owner's consultant.

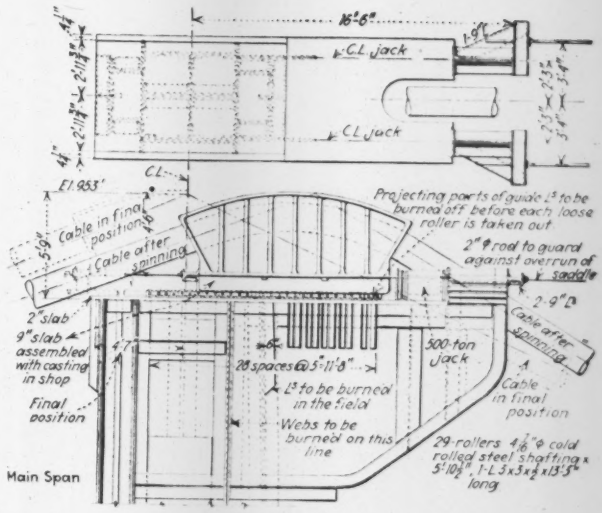

CL Jack
CL Jack
CL
El 933'
Cable in final position
Cable after spinning
Projecting parts of guide L's to be burned off before each loose roller is taken out
2" ϕ rod to guard against overrun of saddle
2" slab
9" slab assembled with casting in shop
Final position
28 spaces @ 5'-11 3/8"
L's to be burned in the field
Webs to be burned on this line
500-ton Jack
Cable in final position
Cable after spinning
29 rollers 4 1/16" ϕ cold rolled steel shafting x 5'10 1/2", 1-L 5x3 1/2 x 13/16" long
Main Span

FIG. 6—JACKING ARRANGEMENT USED IN MOVING SADDLE CASTINGS AS MAIN SPAN LOAD IS ADDED

Brackets are temporary for carrying the pairs of 500-ton jacks. The saddles are shifted a distance of 63 in. riverward during erection of the suspended span.

LOAD AND STRESS SPECIFICATIONS

Roadway Live Load:
- For main span floor stringers, a 24-ton truck
- For main span floor beams and suspenders, eight 21-ton trucks
- For approaches, series of trucks four abreast, as follows:
  - If one row.....24 tons each
  - If two rows.....21 tons each
  - If three rows.....18 tons each
  - If four rows.....15 tons each
  - If five or more rows.....12 tons each, or 100 lb. per sq.ft.

Total live load for main span cables, towers, stiffening trusses and anchorages:
- Normal .....1,650 lb. per lin.ft. (about 30 lb. sq.ft.)
- Congested .....3,300 lb. per lin.ft. (about 60 lb. sq.ft.)

Impact Addition—30 per cent on floor slabs, joists and stringers

Loading combinations for main span cables, towers, stiffening trusses and anchorages:
- *DW* = dead and 40-lb. wind
- *DNWT* = dead and normal live and 20-lb. wind and 60 deg. temperature
- *DCT* = dead and congested live and 60 deg. temperature

Stresses = Carbon steel on an 18,000-lb. basis and silicon steel on a 24,000-lb. basis.

Main Towers—Each main tower is composed of two columns 67 ft. apart with crossbracing and a height from

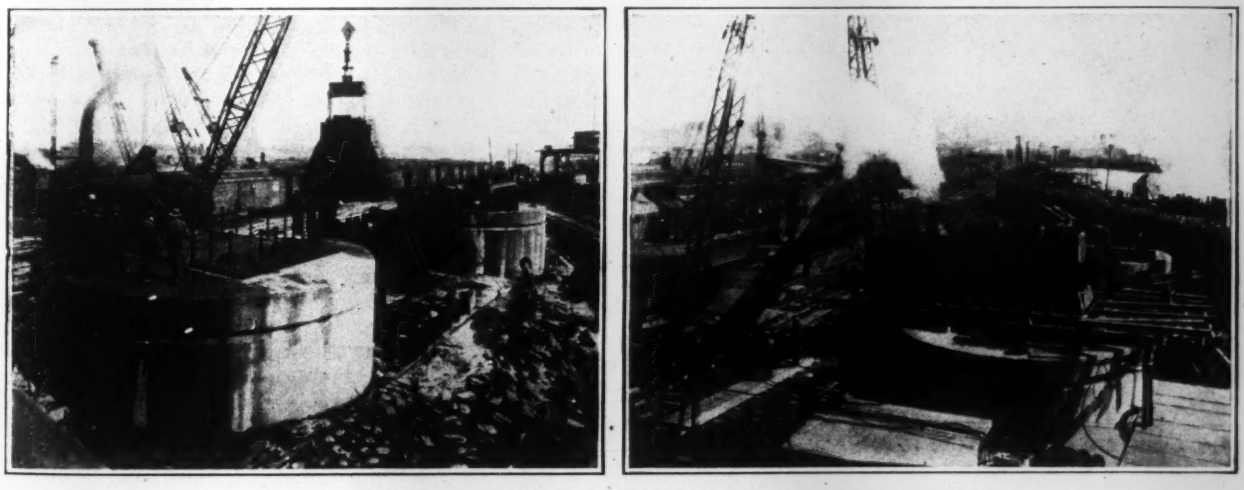


FIG. 5—SETTING BASE STEEL ON THE UNITED STATES MAIN PIER

The left-hand view shows the placing of one of the base sections, while on right the first main section of the tower weighing 54 tons is being raised. Note on far pier in left-hand view the pneumatic machine used to prepare pier for base slab.

masonry to cables of 363 ft. A column comprises three nearly square cells of silicon steel. All angles are 8x8x$\frac{3}{4}$ in. and all plates are $1\frac{1}{2}$ in. in two thicknesses of $\frac{3}{4}$ in. each. The central cell is continuous in dimensions from base slab to saddle casting. Its longitudinal webs are 58 in. and transverse webs 72 in. To the latter are attached all transverse bracing and floor supports. The side cells have 48-in. transverse cover plates, being narrower transversely than the central cell to which they rivet.

The longitudinal webs of the side cells are 54 in. wide throughout about the lower two-thirds of their height, above which they taper to 18 in. under the saddle castings. All studies preceding the final design contemplated a similar taper in the lower third, but the consultant for the purchaser pointed out that by omitting this lower taper and carrying the normal shaft material straight down without change, base castings could be dispensed with and a semi-fixed base in structural steel substituted with the maximum fiber stress under flexure within permissible limits. The term "semi-fixed" is here used because the proportions of the base would not permit of erecting the shafts to their entire height without exterior support, as was the case with the flared-base towers of the Manhattan, Philadelphia-Camden, Poughkeepsie and Mount Hope bridges. The lack of full-height stability (before placing of cables) is in this case no objection, since the deck-truss side spans, with supporting piers, afford a simple means of temporarily staying against longitudinal forces.

It is to be doubted, however, whether the adoption of this type of base makes any particular contribution to the previous discussion of fixed vs. hinged tower for suspension bridges. It is not a sufficiently general case. The long straight backstays, which must have full sag while spinning and must be picked up to near straightness by the erection of the suspended span, compel an initial setting of the saddle casting 63 in. shoreward from the column center, with heavy brackets to support the load thus eccentrically and to provide reaction for the pairs of 500-ton jacks which will be used to roll the saddles over the column centers as the main span load is added. All this is very expensive; but with towers of the hinged-base type the saddles would have to be similarly set off column centers, as was done at Florianapolis, or else the towers would have to be leaned back out of plumb by the same 63 in. and the problem of supporting their enormous weight in that position would also involve expensive steel supports and jacking devices as well as additional strength in intermediate pier foundations. In the absence of a completely detailed plan for these operations it is not practicable to prove, but is the belief of the contractor, that the adopted type is best suited to the immediate case.

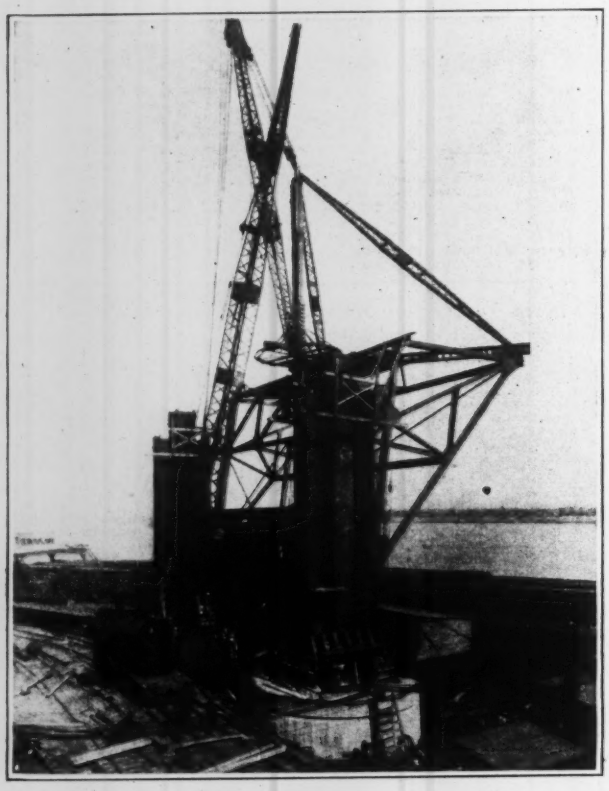


FIG. 7—ERECTING THE UNITED STATES MAIN TOWER
The erection rig is a stiff-leg derrick on a climbing underframe mounted on the river face of the tower. On the United States side a locomotive crane erected the first sections of the tower and the derrick and underframe, while on the Canadian side the initial erection was done from a stiff-leg derrick on pile clusters in the river.

Contact between column and masonry is through a 4-in. machined steel slab, in two pieces, each $6\frac{1}{2}$x18 ft. The base proper is $8\frac{1}{2}$ ft. high, tapered four ways to contract the area covered from $11\frac{1}{2}$x$16\frac{1}{2}$ ft. on the base slab to 6x$14\frac{1}{2}$ ft. under the first column shaft. It is riveted up in vertical cells, the principal webs of which bear on the column webs. There are no lug angles or riveted attachments to the base slab, but a vertical boot around the whole engages the anchor bolts. The base is divided for shipping purposes into five transverse slices, of which the central one weighs 24 tons. After erection and riveting, these bases were immediately filled with concrete.

The lowest column section is special in that the 48-in. transverse cover plates of the two side cells, together with their attaching angles, flare out so that when the base is reached they equal the 72-in. width of the central cell. Above this section, the column remains in large part typical save for floor and truss connections. Horizontal diaphragms are spaced 7 ft. 3 in. apart throughout. Horizontal splices in the two side cells are staggered with those in the central cell. There are seven lifts to each shaft, the heaviest section weighing 58 tons.

The top lift of the side cells is milled short of the center cell and horizontal filler plates are provided under the cap plate. These fillers were planed in Detroit, after all the shafts were erected, so that minute errors in milling the various shaft sections to length are compensated for.

The top lift is quite special in having built into it the heavy brackets for eccentric support of the saddle casting on rollers. These excess portions of shaft will be burned off after they have performed their function, and the slots through the 72-in. transverse web will then be welded up. The saddle castings are standard in type, but a special provision required is the 9-in. slab provided under them to give space for travel of the jack plungers.

The tower transverse bracing is of carbon steel in boxed two-channel sections about 48x58 in., 48 in. being the depth of the channel webs. The top and bottom struts are deepened and are in effect lattice trusses. The usual transverse strut of the roadway portal is omitted in order to avoid any feeling of constricted headroom; and for consistency of appearance the transverse struts are omitted from the X-panels above this.

FIG. 8—UNITED STATES TOWER COMPLETE WITH FOOTWALK CABLES IN PLACE

The second tower was completely erected 11½ months after the contract went into effect and the footwalk ropes were hoisted to place on Aug. 8.

Main Cables—Wire was selected for the cables without detailed comparison with eyebars, because of the higher cost of the anchorage in the latter case. The specification adopted for the cable wire was a virtual duplicate of that used for the Philadelphia-Camden bridge, except that basic steel was admitted on equal terms with acid. Before award of a subcontract for the wire, however, the American Cable Company came forward with evidence that it could go into adequate production of a heat-treated wire with a minimum yield point of 190,000 instead of the specified 144,000 and a minimum tensile strength of 220,000 as against 215,000 specified. All the properties of this wire were found suitable, and it was permitted to compete with the cold-drawn wire on the basis of a working stress increased from 76,000 to 84,000. With this advantage, the best offer received for the cable wire in place was on the basis of the heat-treated wire; this is now in satisfactory production and shipments to the bridge site have begun. Each cable comprises 37 strands of 206 No. 6 galvanized wires. Had it been known three months earlier that the new wire would be available, the design might more economically have been based on 19 instead of 37 strands. Under present conditions the west or sidewalk cable will not be so highly stressed as the east cable, on which the design is based; but in all parts of the bridge this difference is neglected to care for any possible future change of pavement layout.

The suspender arrangement is usual and the strand shoes, suspender sockets, cable bands and splay castings are of cast steel, of types which have become practically standardized on the last few important suspension bridges.

Suspended Span—The design finally adopted for the stiffening trusses used a panel length of 24 ft. 2⅜ in., and a truss depth of 22 ft., omitting overhead bracing, and staying the top chords by floorbeam brackets. After careful comparison of several different types of floors, a 6-in. concrete slab with 4½-in. welded truss reinforcement and a 2½-in. covering of sheet asphalt was adopted.

The stringers, spaced 4 ft. 8 in. centers, are figured as of simple span, though they will be fabricated in two-panel lengths. They are supported on instead of framed into the floorbeams to eliminate dangerous deformations in the framed connections during passage of the erection traveler.

The floorbeams are single-web plate girders of carbon steel. Their end connections are quite unusual, in that the bottom chord gussets of the stiffening trusses are to be built with the floorbeams at the shop. This will make for simplicity in erection. At its first pass the traveler will hang the floorbeams from the suspender ropes, hoist the bottom chord into the space between gussets and hang it on a few bolts, set the laterals and enough stringers to run on, and proceed. The cable distortions, which are bound to be severe in this stage, will thus be no obstacle to speedy completion of the first pass.

In the floorbeam design it is assumed that, of the live loads indicated, the excess stops at the stiffening truss and only so much travels out to the suspenders as represents a one-panel quota of the intensity assumed for all panels loaded. To provide, however, for possible misadjustments of suspender shims, by which one or more suspenders might be receiving too much load, the total suspender pull is increased 10 per cent for the floorbeam design.

The stiffening truss chords are of silicon steel and the webs of carbon steel. The permissible unit stresses are increased one-third over those for other parts of the structure, and are accordingly based on 32,000 for silicon and 24,000 for carbon steel. All stresses are worked out for the load combinations in the accompanying table by the "deflection theory," using in the calculations the actual sizes of members that are now being fabricated. Top and bottom chord sections are increased by wind stress throughout the central half of the span and by congested live loading (without wind) in the end quarters.

Chord areas (silicon) vary from 60 to 75 sq.in. gross for the top, and from 47 to 70 sq.in. gross for the bottom. Web diagonals are uniformly two 15-in. channels at 33.9 lb., except in the five panels at each end, where they are progressively stepped up to equality with the top chord section; this is for consistency with the overload assumed as a precaution against misadjustments in the rocker which provides the truss support on the tower. Bottom chords are spliced at main panel points near the centers of main gussets, being fabricated as straight members approximately 48 ft. long.

Concreting of the floor is to proceed both ways from the center of the span, and during concreting the riveting of chords and diagonals is to proceed as the dead load radius of curvature is locally approximated. At least one joint in eight is to be left unriveted until concreting is completed and the placing of the asphalt pavement is under way. This will preserve as nearly as practicable the distribution of dead load between truss and cable assumed in the design.

Organization—The McClintic-Marshall Company, Pittsburgh, is engineer for the design of the bridge as well as the general contractor for its entire construction.

As general contractor, the McClintic-Marshall Company has already awarded the following subcontracts: core borings, Pennsylvania Drilling Company, Pittsburgh; wrecking, United States approach, Fulton Lumber & Wrecking Company, Detroit; wrecking, Canadian approach, General Wrecking Company, Detroit; main piers and anchorage substructures, the Foundation Company, New York; Canadian approach piers and terminal walls, Merlo, Merlo & Ray, Ford City, Ont.; Canadian approach steelwork, Canadian Bridge Company, Ltd., Walkerville, Ont.; United States auxiliary piers, engine house group, H. H. Esselstyn, Inc., Detroit; United States approach piers, Walbridge Aldinger Company, Detroit; United States terminal walls, H. H. Esselstyn, Inc., Detroit; main span cables, suspenders and hand rope, Keystone State Corporation, Philadelphia.

The subcontractor last named has in turn placed the order for the wire with the American Cable Company, which is producing it at the plant of its subsidiary, the Page Steel & Wire Company, Monessen, Pa. This subcontractor has engaged Robinson & Steinman, New York City, as consulting engineers on cable erection. Except as above noted, the McClintic-Marshall Company is fabricating all steelwork at its Rankin, Pa., shop and is erecting it with its own forces. Robert MacMinn, succeeding E. J. Paulus, engineer of construction, is in entire charge of operations at the site, and R. G. Cone is resident engineer for the bridge company's consultant.

The McClintic-Marshall Company has retained Moran, Maurice & Proctor, New York City, as consulting engineers on main foundations, Leon S. Moisseiff as consulting engineer on the main span suspended structure and Monsarrat & Pratley, Montreal, to give all important elements of the design an independent review. On all architectural matters Smith, Hinchman & Grylls, of Detroit, are consulted. For the Detroit International Bridge Company, Modjeski & Chase are acting as consultants for both design and construction.

Air-Activation Gaining at Birmingham

The decision to install a 12-Imp. m.g.d. activated-sludge plant with air diffusion through porous plates at the sewage-works of the Birmingham, Tame and Rea Drainage District, England, taken in conjunction with the history of activated-sludge treatment at these works, shows that diffused air is gaining ground over mechanical means of activation at these works. According to the London *Surveyor* of Aug. 10, bids for such an installation have been accepted by H. C. Whitehead, engineer of the district, following sanction of the project by the Ministry of Health. The earlier history of activated-sludge practice at Birmingham is thus summarized by the *Surveyor*: "Starting in 1922 with a plant operated wholly on mechanical lines, and working through a combination of 'spiroflow' and 'Simplex' methods of treatment, the usefulness of the plant has within the last eighteen months been extended by the addition of a diffused air unit for reactivation of the sludge. It has also been demonstrated that the addition of a number of diffusers to the 'spiroflow' flocculation plant effects a further improvement and increases the effective capacity of the plant. . . . A number of diffusers sufficient to give a run of about 1,000 ft. are being added . . . and with the addition of these it is hoped to increase the flow treated [by the existing installation] from 8 to 12 Imp. m.g.d." It should be noted that the sewage of this district goes to sprinkling filters for final treatment.

Fast Concrete Roadbuilding Under Rush Orders

Ten-Mile Link in Fifty-Mile Galveston-Houston 20-Ft. Concrete Road Paved at Rate of 1,170 Ft. a Day on Fresh Fill—Methods of Compacting

By A. J. Wise

County Engineer, Harris County, Houston, Tex.

A NOTABLE example of rapid roadbuilding is afforded by the construction early this spring of the 10.4-mile link necessary to complete the 20-ft. all-concrete highway from Galveston to Houston, Tex. The haste to build the road was prompted by the fact that the Democratic convention was to be held in Houston. It was desired to provide quick and comfortable access by motor car to the convention city to that part of the convention crowd which had arranged to live in Galveston. It happened fortunately that all

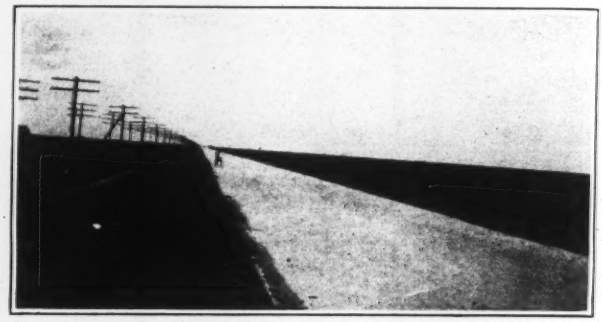


FIG. 1—COMPLETED ROAD OVER SWAMP KNOWN AS ELLINGTON FIELD GAP
Note the posts set for the 3-mile guard rail at this point. A wire-mesh guard rail was employed.

the plans for construction had been previously completed and approved by the State Highway Commission and the Bureau of Public Roads.

Bids for the construction of the road were received on Jan. 30, 1928, and the contract was awarded to A. A. Davis & Company of Kansas City, Mo., at its bid price of $367,286. The contract required the work to be started by Feb. 22 and the pavement to be completed in 75 working days. The contractor gained fifteen days by starting his camp and preparations for grading on Feb. 6. Exactly one month later, on March 6, his forces began to pour concrete pavement. The 10.4 miles of pavement slab was finished at 10 a.m. May 19, about twenty days ahead of the contract time. In 30 days more the shoulders were completed. The finished road in view of its speedy completion challenges admiration.

Paving on Fresh Fill—It is believed that this is the first time in Texas roadbuilding, if not in roadbuilding anywhere, that paving immediately following fresh fill and new bridge work has been undertaken on so large a scale. The methods followed, it is thought, although never before employed in Texas, are in keeping with sound engineering practices and will serve as a precedent for future similar operations. Of course several years of observation will be required to demonstrate conclusively what amount of settlement there will be, but there is confidence that it will not be injurious.

Grading Problems—The grading of the new road presented an unusual set of problems. To begin with, the

right-of-way was widened from 60 ft. to 100 ft. This required moving 28 houses, one railway station and a town well 832 ft. deep. Then, it was the original intention of the county authorities to widen the right-of-way only to 80 ft., and certain bridges and small drainage structures had been constructed on the center line of this 80-ft. right-of-way zone. When then it came to locating the new pavement on the 100-ft. right-of-way, which paralleled and was restricted by the Galveston, Houston & Henderson Railroad on one side, it came 40 ft. from one right-of-way line and 60 ft. from the other, as shown by Fig. 2, which indicates the two types of grading employed.

The old road was located in the middle of the 60-ft. right-of-way, with an average fill of 1 ft. topped with

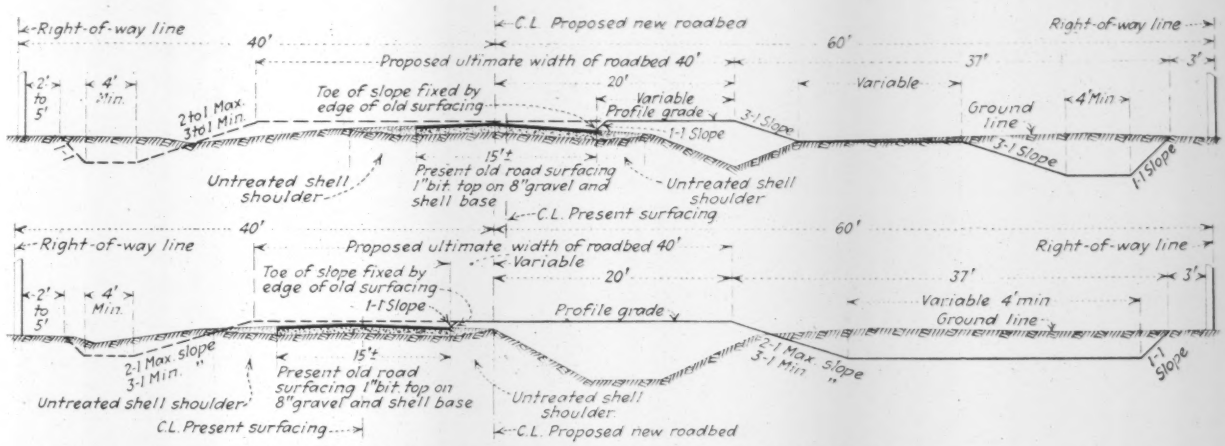


FIG. 2—TYPICAL GRADING SECTIONS ON GALVESTON-HOUSTON ROAD

about 10 in. of shell, with an inverted penetration asphalt surface treatment. The plans for the new road called for a concrete slab on an embankment from 1 ft. to 2 ft. high on a center line 10 ft. from the center line of the old road. Therefore the new slab was located partly over the old road and partly over a ditch, making the depth of the fill on one side from nothing to 1 ft. and on the other side from 2 ft. to 5 ft.

It was necessary to scrape the old road metal to one side, fill up the ditch, build the road crown to a 40-ft. width and construct a new ditch varying from 18 in. to 4 ft. deep to fit in with a drainage scheme for the low, flat country which the highway traverses. The new ditch was constructed approximately 40 ft. from the edge of the concrete slab on the wide side of the right-of-way and 20 ft. on the side next to the railroad right-of-way.

The old drainage ditch was filled in layers, puddled and compacted by running a 10-ton tractor over each layer while wet. This work was done with elevating graders and draglines for the heavier grading and with mule teams for the lighter fills. The dirt placed by the elevating graders was compacted by deadheading the return trips over newly placed dirt. In addition a 10-ton tractor was kept running continuously over the new embankment as layers of dirt were placed. This part of the work continued day and night.

It was found that rolling with a tractor was more efficient than with a roller, because the latter could not be used in wet dirt and could be operated successfully only after the soil near the surface had dried out sufficiently to keep the roller from bogging down.

Before the concrete slab was placed the embankment was tested thoroughly to ascertain if any voids existed in it. This was done by test holes.

The soil for about one-half the distance was of a sandy loam and for the other half a black gumbo. At about mid-length of the new road there is a swamp 2 miles long, known as the Ellington Field Gap (Fig. 1), which has been a source of continual annoyance and failure. The original shell road was a total failure. It was rebuilt of shell and failed; it was again rebuilt of gravel and likewise failed. Later it was rebuilt of crushed rock and a surface treatment applied. This stood the traffic fairly well, but some shifting of the soil took place and the road became wavy. The top soil of the Gap consists of a stiff muck about 2 ft. deep underlain with black gumbo. The drainage was poor, and during wet weather, when the sub-soil was thoroughly saturated, subsidence took place to such an extent as to cause failure. A drainage ditch was constructed with a 16-ft. bottom width, varying from 4 ft. to 8 ft. deep, about 2 miles long to a natural outlet. It is believed that with the area drained in this way the concrete slab will distribute the weight of the traffic sufficiently so that the road will bear up under all conditions.

The old road metal, which consisted of shell except through the Ellington Field Gap, where it was of shell, gravel and crushed rock, was used as subsoil treatment and worked into the top layer of the embankment. This enabled the subgrade to be rolled with a 10-ton roller while the soil was still in a plastic condition. It has been observed that better results can be obtained by thus building a crust sufficient to bear up a roller while the subsoil is plastic than if the subsoil is dry; a much better compaction can be obtained. Experience in this coast country has proved that it is much safer to place a road surface on a wet subgrade, if it has been properly compacted, than on a dry subgrade.

Pavement Structure—The concrete slab was of the Bates type, 9 in. thick on the edges and 6 in. in the center, with 40 lb. of mesh reinforcement per 100 sq.ft. plus six ½-in. rods placed longitudinally in the pavement, two on each edge and two in the center. Prepared expansion joints 1 in. thick were placed 78½ ft. apart. The details of this slab structure are shown by Fig. 3.

Construction Plant and Methods—A notable construction organization and plant were developed. The working force consisted of plant foreman, mixer foreman, subgrade foreman, grading foreman, timekeeper, bookkeeper, mechanic, blacksmith, bridge foreman and about

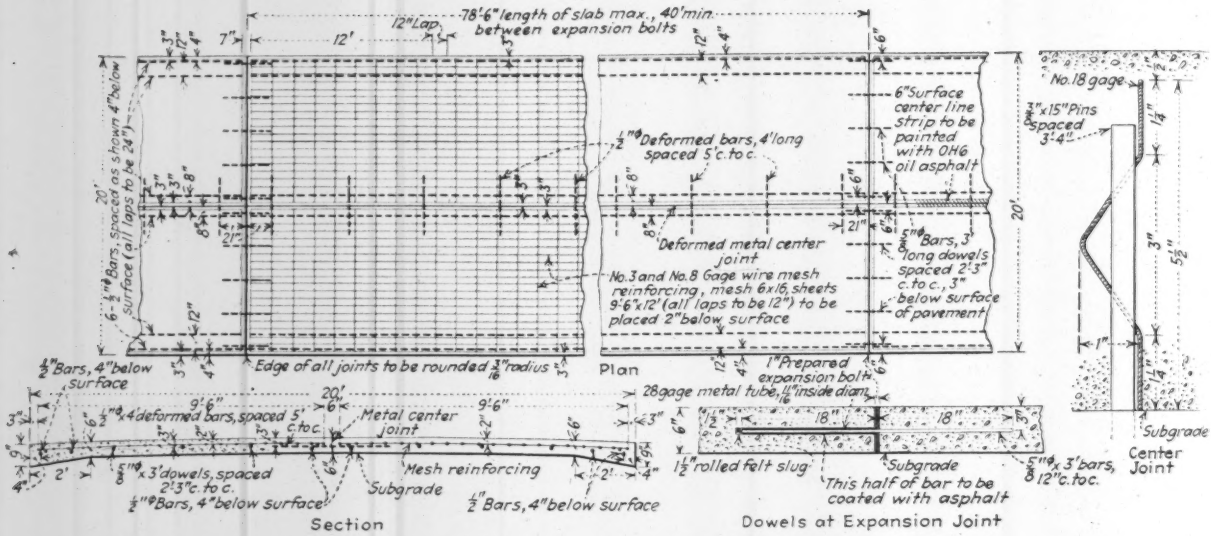

78'6" length of slab max., 40' min. between expansion bolts
12" Lap
Plan
6" Surface center line strip to be painted with OH6 oil asphalt
Deformed bars, 4' long spaced 5' c. to c.
Deformed metal center joint
No. 3 and No. 8 Gage wire mesh reinforcing, mesh 6x16, sheets 9'6"x12' (all laps to be 12") to be placed 2" below surface
5/8" Bars, 3' long dowels spaced 2'3" c. to c., 3" below surface of pavement
No. 18 gage
3"x15" Pins spaced 3'4"
Subgrade
Center Joint
Edge of all joints to be rounded 3/16" radius
1" Prepared expansion bolt
28 gage metal tube, 1 1/16" inside diam.
1/2" Bars, 4" below surface
Metal center joint
Mesh reinforcing
Subgrade
1/2" rolled felt slug
This half of bar to be coated with asphalt
Section
Dowels at Expansion Joint

FIG. 3—DETAILS OF PAVING SLAB, GALVESTON-HOUSTON ROAD

150 laborers. These men were taken care of by a mess hall, bunk houses and commissary. The following equipment was used:

85 teams	One finisher
Five 60-hp. caterpillar tractors	8,000 ft. steel forms
Four elevating graders	One turntable
Four 12-ft. leaning blade graders	36 motor trucks
Five light plants	One cement bag cleaner
One dragline excavator	Two rollers
One locomotive crane and clam-shell	One 2-in. centrifugal pump
	10 miles of 3-in. waterline for paver
Three batcher bins	
Three road pumps	10 miles of 2-in. waterline for curing
One paver	
One subgrader	Two scarifiers
One form grader	Three supply trucks
One subgrade planer	Six passenger cars

The reason for so many pumps was that in the hot climate of eastern Texas one was required for the mixer, one for curing and one for jetting the fill. Also the three service trucks for the mixer were required largely because of the amount of reinforcement to be handled. Being constructed in 42½ days, the paving slab was put down at an average rate of 1,170 ft. a day.

On the grading work and in preparation work ahead of the paver, crews were kept on the job every day in the week and 24 hours a day. Portable electric light plants were used to keep the ground thoroughly lighted at night, and work never stopped except when weather conditions were too severe.

There was a plentiful supply of day laborers, including white men, Mexicans and negroes, recruited in Houston and vicinity. The contractor operated his own machine shop and did practically all of the repair work. He developed a splendid working organization and never had the slightest labor trouble.

FIG. 4—SOFT SUBGRADE KEPT PAVER OUTSIDE OF FORMS

Representatives of the Bureau of Public Roads and the state highway department were on the job continually, reported regularly on the progress of the work and made a thorough study of all details of the operation.

Many Shipping Accidents Occur at Bridge in Vancouver, B. C.

THE bridge across the second Narrows of Burrard Inlet at Vancouver, B. C., was built in 1925, and since that time accidents to shipping, due chiefly to collision with the piers, have been frequent. The tide through the Narrows attains a speed of seven knots per hour and much of the traffic to points farther up the inlet consists of log booms or scows in which tug and tow represent a considerable over-all length. When weather conditions are adverse it has been found extremely difficult to carry on towing business safely under this bridge. That the collisions do not involve only the towboats, however, is shown by the following list of accidents at the bridge, recently published in Vancouver:

Date	Nature of Accident	Damage
Sept. 8, 1924	Logs in tow of tug "Shamrock" fouled pier	$16,000
Nov. 3, 1924	Log boom broken up in collision with pier, Cliff Towing Company	400
Sept. 30, 1925	Tug "MT No. 1" sunk in collision with bridge	3,000
Sept. 30, 1925	Vancouver Lumber Company scow damaged	700
Nov. 26, 1925	S.S. "Canadian Ranger" drifted into bridge, saved by tug	Unstated
Dec. 1, 1925	Tug "Lorgnette" collided with pier	Unstated
Jan. 5, 1926	S.S. "Canadian Ranger" hit north pier	1,070
Jan. 9, 1926	Oil tanker "Mina Brea" hit pier	8,000
Feb. 25, 1926	Oil tanker "Mina Brea" collided with pier	1,200
Feb. 27, 1926	Oil tanker "Vancolite" hit pier	1,000
Apr. 11, 1926	Boom of logs broken up, lost	600
Apr. 14, 1926	Cliff Towing Company scow damaged	3,000
Apr. 14, 1926	Gas boat "Chummy 2" struck pier, crushed by scow, sank	Unstated
May 5, 1926	Scow in tow of "Seal Swell" collided with pier	1,040
May 25, 1926	Tug "Pacific Monarch" hit pier	Unstated
July 26, 1926	Boom in tow of "B. C. Boy" hit pier No. 2	Unstated
Mar. 10, 1927	S.S. "Eurana" struck fixed span	30,000
	Tug "Shamrock" fouled pier	9,694
Apr. 24, 1928	S.S. "Norwich City" struck fixed span	50,000
	Total	$125,704

To give some indication of the amount of traffic through the Narrows it may be said that in the period covered by the list of accidents the draw-span was opened for the passage of a daily average of sixteen vessels. The width of the channel between piers is 160 ft. Except for timber pile dolphins up and down stream from the piers, no fender protection was provided.

Activated-Sludge Plant Produces Fertilizer at Pasadena

Tri-Cities Plant Serving 120,000 People Handles 7 M.G.D. of Sewage, Producing Sludge Cake Which Is Dried, Ground and Sold for $25 Per Ton—Gases Incinerated to Prevent Odors

COMMERCIAL FERTILIZER FROM SEWAGE has been produced at the Pasadena sewage-works, as described in the following article. This result was not achieved all at once or by the application of some well-tried formula, for in the four years since operation began extensive reconstruction of important features of the plant has been necessary repeatedly. The combination of circumstances and conditions at Pasadena presented great difficulties, as has been the experience at the Milwaukee and Houston activated-sludge plants. —EDITOR.

THE SEWAGE-WORKS of the cities of Pasadena, South Pasadena, Alhambra and San Marino, Calif., which serves a population of about 120,000, is now said by those in charge to be on a highly satisfactory operating basis after a process of development and adaptation extending over the four-year period since the plant was built. A different method of operating the aeration tanks has been tried out, some of the clarifier plows have been changed to spirals, helical sludge pumps have been replaced with centrifugal pumps and the sludge, after being conditioned with alum and diatomaceous silica, is now filtered, dried and finally ground into fertilizer of high nitrogen content for which there is always a demand in the citrus orchards, golf courses and nurseries near this plant.

The dried fertilizer produced amounts to about 8 tons daily, with 2 tons more available which will be produced as soon as additional drying equipment can be installed. The available amount of dried fertilizer (only 5 per cent moisture content) totals about 1½ tons per million gallons of sewage. The other solid product of the plant, amounting to 6 to 8 cu.yd. daily of screenings containing 85 to 90 per cent moisture, is buried in shallow trenches in the gravel bed of the stream bottom adjoining the plant. Very satisfactory results are reported to have been obtained by passing the major part of the screenings through the plant and drier, thereby increasing the fertilizer output during the low-flow season. Obviously this plan is not practicable when the plant is carrying maximum load.

The quantity of raw sewage delivered to the plant has increased materially since the original installation and now ranges from 5 to 7 m.g.d., with peak flows for a four-hour period at a rate of 10 to 12 m.g.d. and for shorter periods at a rate as high as 15 m.g.d. To take care of the increased flow there have been added a 10-m.g.d. drum-type screen (making the total screen capacity 16 m.g.d.), twelve new aeration tanks and two settling tanks, besides considerable equipment, mentioned below, not originally contemplated. A description of the plant as originally built appeared in *Engineering News-Record*, Oct. 29, 1925, p. 714.

Baffles have been placed in the aeration tanks, consisting of 1-in. boards extending from 2 in. above the water level down to within 1½ in. of the top of the pyramids that separate the diffuser plates. Six baffles in each tank divide it into six 10⅓x10-ft. and one 5¼x10-ft. compartments. In each of the large compartments two pipes convey air to diffuser plates set in the bottom. The small compartment has one air lead to one row of plates.

Experiments have been made with alternate air leads shut off, thus setting up a spiral circulation within each compartment, at right angles to the direction of flow through the tank. This circulation has increased the surface exposure, giving more atmospheric oxidation and perhaps some reduction in the amount of compressed air required. It will be possible to compare results with spiral and with vertical circulation. The aerated sludge from tanks operated by the two methods is conveyed to different settling tanks in which floc formations and general results will be observed and compared.

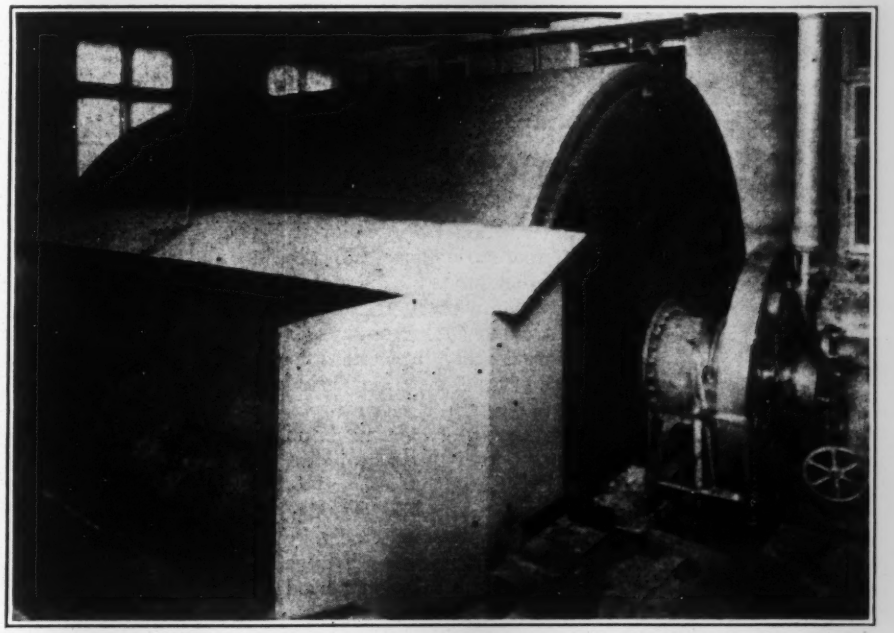


FIG. 1—ONE OF THE THREE FILTERS THAT DEWATER SLUDGE
Sludge cake of about 80 per cent moisture content is being removed by the scraper from the drum surface. Above and at the side are metal guards to prevent wash water from splashing when the filter cover is hosed off.

The use of re-aeration tanks was discontinued for a while, but this has now been resumed, because it was found that the particles of floc which return into the raw sewage function much more effectively when re-aerated, especially after being pumped from the clarifiers to the re-aeration tanks.

Blower capacity has been increased in proportion to the additional aeration tanks added, the new blower having a capacity of 5,400 min.-ft. The total compressor capacity of the plant is now 13,000 min.-ft. During January, 1928, the air consumption for all purposes, including the vacuum filters, was 1.29 cu.ft. per gallon of mixed liquor handled. The total air demand at the plant is now about 15,000,000 cu.ft. per 24 hours, delivered under a pressure of 9.5 lb. per square inch.

Changes in the settling tanks have included rebuilding all the old substantially square bases to give a circular base section. In the original mechanisms installed two of the four arms, with plow blades attached, in each tank had extension arms that swept into the corners. These extensions are now removed and all the old tanks will soon be equipped with spiral scrapers, which show equally satisfactory operation with much less maintenance. One new tank, 50 ft. in diameter, was built with a square top and circular bottom and was equipped with a spiral scraper driven by a variable-speed motor, the speed adjustment ranging over a 2½ to 1 ratio. The vertical-shaft helical pumps that were installed for handling excess sludge have been replaced with 8-in. centrifugal pumps of the open-runner type, each driven by a 10-hp. variable-speed motor.

Two 40,000-gal. concrete tanks of somewhat the same general shape as the aeration tanks were completed in February, 1928, at one end of the plant, for conditioning sludge prior to filtration. These tanks replace the 5,000-gal. dosing tanks previously used and thus make it possible to add diatomaceous silica and alum to a batch of eight times as much sludge at one dosing. The present output is such that six to eight 40,000-gal. tanks of sludge are passed daily through the filtering plant, thus allowing approximately three hours for each cycle of filling, dosing and mixing in the conditioning tanks. To accomplish the desired admixture of alum and diatomaceous silica a diffuser-plate system has been installed arranged to secure spiral circulation of the sludge.

In addition to experimental work that these new conditioning tanks make possible, they have several decided advantages: (1) There is a large saving in labor in adding the coagulant and diatomaceous silica; (2) the sludge fed to the filters is somewhat more uniform over a 24-hour period; (3) a much closer check is secured of the actual amounts of conditioning agents used; (4) the air employed for agitation in mixing the conditioning agents also serves to prolong the re-aeration period of the sludge prior to filtration, and so improves its condition, provided the re-aeration is not continued too long; (5) the alum can be added in a dry form, thus saving considerable air and labor formerly involved in getting it into solution; (6) if desirable, only sludge which has had at least the average aeration period may be filtered without the necessity of filtering sludge formed during the peak flow when the aeration period is short.

In experimenting with diatomaceous silica, the dosage was varied until 15 per cent by weight of the dry finished product was found to give the maximum advantage in the filtration process. This is the equivalent of 11 lb. per 1,000 gal. The diatomaceous silica used up to the time this article was written cost about $30 per ton delivered at the plant. A cheaper form of diatomaceous silica costing about $20 delivered at the plant was tried experimentally with practically the same results in both filtering and drying. Then it was found that a near-by lemon products plant has a waste product of used high-grade diatomaceous silica amounting to 3 tons daily which contains only a small quantity of organic matter. This material, which can be had for the cost of hauling and handling, was tried and was found to be nearly as effective as fresh diatomaceous silica. Further experiments are being conducted on both of these materials.

Experiments were made in a small way with other filter aids, such as oil-gas carbon, spent oil shale, coke breeze, etc. None of these was found superior to diatomaceous silica.

The alum dosage has also been varied experimentally

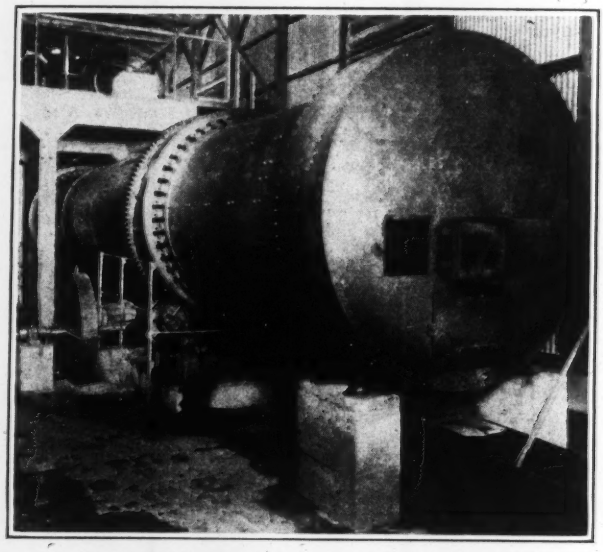


FIG. 2—DISCHARGE END OF THE ROTARY DRIER
In this cylinder heated gases reduce moisture content of sludge from 80 to 5 per cent.

from 8 to 14 lb. per 1,000 gal. and has been reduced materially by the use of diatomaceous silica, which causes a decrease in the moisture content of the filter cake of about 5 per cent compared with the optimum result obtained with alum alone. Normally about 1 to 1½ tons of alum is used per day, this being the quantity figured for about 250,000 gal. of filtrate.

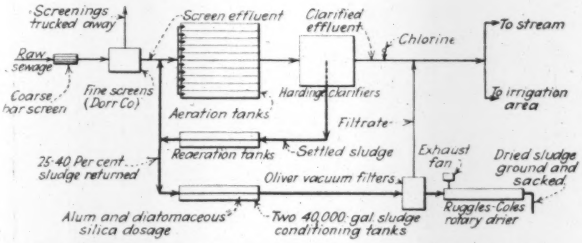
Experiments have also been made using ferric chloride, produced locally as a waste product from a chemical plant, which can be bought at less than 3c. per pound in commercial quantities. Using this product operators of the plant believe that improvement over the results obtained with alum can be shown in the rate of filtration and in the decrease of sludge-cake moisture content.

Three vacuum filter units have been installed in the filter plant and these will each filter about 6,500 gal. of sludge per hour, delivering a cake containing 78 to 80 per cent moisture. On the belt conveyors that move sludge cake from filter to drier steel disks are placed at intervals, set so as to be rotated by the motion of the belt. These disks cut the sludge cake into small pieces that are more efficiently handled in the drier.

Reduction of the moisture content to about 5 per

cent is accomplished in a drier which is primarily a horizontal cylinder that rotates as heated gases pass through it. The hot gases are provided by a gas-burning combustion chamber whose fuel consumption is about 100,000 cu.ft. per day, rated at 1,000 B.t.u. per cubic foot and costing 20c. per 1,000 cu.ft. Hot gases pass into the drier at a temperature of about 1,800 deg. F. and are drawn through by induced draft. As originally installed, the drier was 42 ft. long, but to make better use of the gases the length has been increased to 60 ft. The outer shell of the drier is 70 in. in diameter and a concentric inner shell has a diameter of 30 in. Hot gases pass first through the inner shell for the full length and then return between the inner and the outer shells to the exhaust fan.

Sludge cake passes through the length of the drier



DIAGRAMMATICAL SKETCH SHOWING SEQUENCE OF OPERATION

only once, remaining between the inner and the outer shells; as the cylinder rotates, longitudinal metal vanes on the inside of the outer and the outside of the inner shell keep it moving and dropping continually through the heated gases. The drier slopes downward from the combustion chamber on a grade of 0.2 in. per foot, and the sludge cake fed in at the combustion chamber end is moved along to the lower end by the rotation. A 30-hp. variable-speed motor turns the drier at 7½ r.p.m. (normal speed), this combination of grade and speed making the time for passing through the drier about one hour. At this speed, about 700 lb. of sludge cake with moisture content reduced to 5 per cent can be delivered per hour.

From a pit at the discharge end of the drier a bucket conveyor lifts the dried product to a 15x18-in. swing-hammer pulverizer that grinds it to a fineness such that it will all pass a ⅛-in. screen. This product, which is packed in 100-lb. sacks and piled in an adjacent storeroom, is known as "Nitroganic" fertilizer and up to Aug. 1 was sold on a sliding-scale price ranging from $40 per ton for 1 ton or less down to $30 per ton for 200 tons and over, f.o.b. the plant. Based on repeated analyses of this fertilizer, the following content, in terms of percentage, is guaranteed: Nitrogen, total, 5.0; phosphoric acid, total, 2.4; potash, 0.3; organic matter, 65.0. Bids recently opened for a three-year contract to take the entire fertilizer output of the plant offered $25 per ton, loading not included.

The gases given off by the drier have a decided odor and if discharged in the air from a stack without adequate deodorization would probably cause protest. After unsuccessful treatment of gases with chlorine, ozone, by washing and in coke towers, the gases were blown into the partly filled outfall sewer, which is 4 miles long. For a while this plan seemed to be satisfactory, absorption being aided by burlap baffles at the outlet. Odors did escape, however, and the outfall disposal of gas was finally abandoned.

The next step was the incineration of the gases—a method that seems to have solved the odor problem. At least it gives promise of being a wholly successful plan. The incinerator consists of a simple combustion chamber surrounded by a preheating duct through which the gases from the drier are passed. The natural gas fuel is fed into the combustion chamber through a burner around which the drier gases are also blown in, thus bringing them in direct contact with the flame. This plan has effected complete deodorization and does not produce smoke, so the products of combustion are passed through a 20-ft. stack directly into the atmosphere. The fan that draws the hot gases through the drier and blows them into the incinerator is driven by a 20-hp. variable-speed motor and has a capacity of 7,500 to 10,000 min.-ft. of gas under the present static pressure. In addition to this main exhaust blower a separate motor-driven blower of small size delivers through a 6-in. air line into the combustion chamber of the incinerator. This blower was installed to aid combustion.

A contemplated addition to the plant is a 1½-m.g.d. equalizing tank used to smooth out the flow of raw sewage. It is to be located at the screen end of the plant and connections will be such that part of the flow can be diverted into it either before or after screening. This tank will make it possible to reduce the peak flow by 6 m.g. for six hours or thereabouts.

The over-all cost of operating the sewage-works, considering it as a fertilizer factory and rating costs in terms of tonnage of fertilizer that can be produced, is about $40 to $45 per ton. In other words, with the fertilizer selling at $30 per ton, the revenue is about two-thirds of the total operating cost.

The foregoing data were furnished by R. V. Orbison, city manager of Pasadena, and the operating staff at the disposal plant, consisting of W. C. Earle, city engineer and superintendent of streets; A. W. Wyman, plant superintendent; W. A. Allen, assistant plant superintendent, and L. H. Biggar, research engineer.

Record Number of Railway Ties Treated in 1927

In 1927 the treating plants in the United States treated 74,231,840 crossties, the largest number ever reported, according to R. K. Helphenstine, Jr., of the Forest Service, U. S. Department of Agriculture. The number of ties given treatment in 1927 exceeded the number reported in 1926 by 11,577,302. Of the ties treated during the year covered by the report, 45,177,218 were hewed and 29,054,622 were sawed. Oak and yellow pine ties again ranged first and second respectively, 37 per cent of the total number reported being oak and 28.2 per cent being yellow pine. Treated Douglas fir ties represented 7.9 per cent, and gum ties 7.3 per cent. Next in order came beech, maple, lodgepole pine and birch. Of the number of ties treated, 52.02 per cent were treated with creosote and 21.27 per cent with creosote in mixture with petroleum. Zinc chloride was used for 10,879,800 ties, while a zinc-creosote mixture was used on 3,716,996 ties. There were 187 treating plants in operation in 1927, seven more than reported in 1926. Ten new plants were constructed during the year. Railway ties represent by far the largest single item in number treated, averaging over a period of years from 60 to 70 per cent of the total quantity of wood annually passing through the treatment plants.

Relation Between Output and Cost in Mixing Concrete

Graph Determined for Calculating Effect on Cost of Curtailment in Yardage Outputs of Concrete Mixing Plants

By William C. McNaughton

Resident Engineer, Rapid Transit Subway Construction Company, New York, N. Y.

MOST contractors know that there is a relation between output and cost in mixing and placing concrete, but the writer does not believe that the true effect is known or its magnitude realized. In developing claims for a subway contractor in New York City in a breach of contract suit a study was made of the effects of placing concrete at decreased output. Two different mixing operations were analyzed and the results put into the form of graphs, Figs. 1 and 2.

Cases and Analysis—In the first operation analyzed the concrete was mixed at a central plant, from which the maximum haul was 2,500 ft. In the second operation the concrete was mixed by two movable plants, and the maximum haul at no time exceeded 100 to 200 ft.

The data considered included only the labor cost of mixing and placing—that is, the cost from the time sand, stone and cement were delivered at the mixer until the concrete was poured into the forms. No charges for handling the raw materials or for formwork were included. There were available from the contractor's records the monthly labor cost and the number of cubic yards placed monthly. The period covered by the records was that from February, 1915, to December, 1917, inclusive.

The first step was to remove from these costs the effect of increase in wages, which had started to go up in March, 1916, and had continued to increase until the job was finished. The adjusted costs were then plotted (Fig. 1) as curve A for the central mixing plant operation and curve B for the operation with portable mixers.

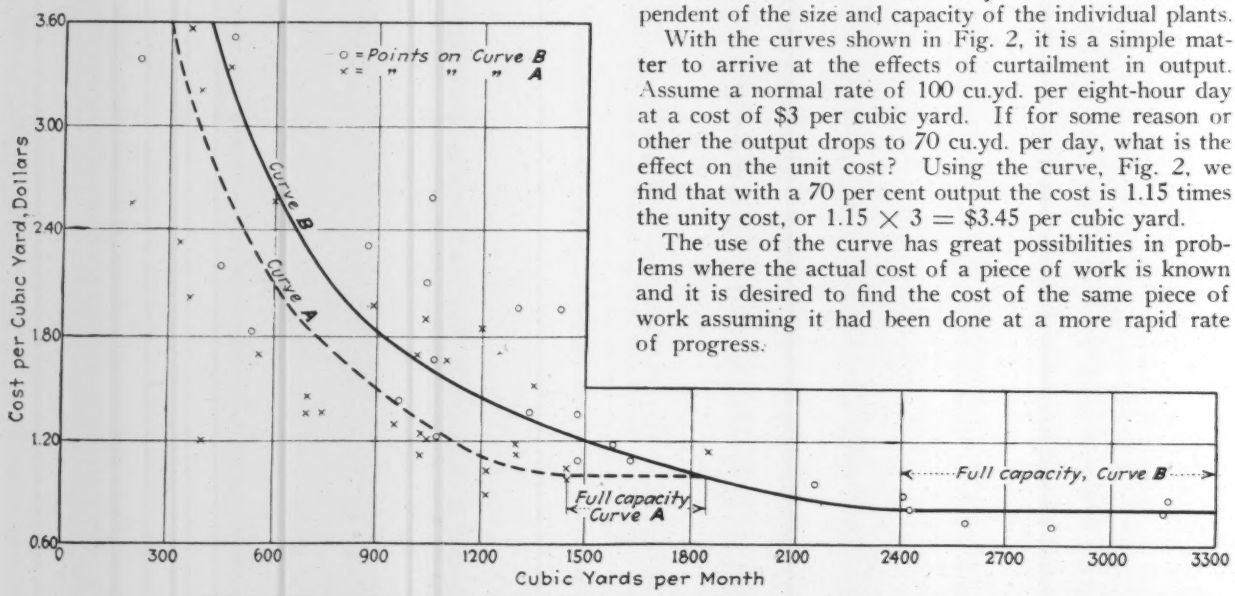


FIG. 1—UNIT COSTS FOR VARIOUS YARDAGE OUTPUTS OF TWO CONCRETE PLANTS

The curves (Fig. 1) showed a marked similarity. They indicated that the cost per cubic yard was constant during the period the plants were operating at full capacity. On curve A this output is shown as extending from 1,450 cu.yd. to 1,850 cu.yd. per month and on curve B from 2,400 cu.yd. to 3,300 cu.yd. per month.

The next step was to secure a curve having general application. The cost per cubic yard at full capacity on curve A was taken as \$1 a cubic yard and the yardage at full capacity as 1,625 cu.yd. a month. Ten points were taken on curve A and the abscissas and ordinates obtained from these points; the values obtained for the ordinates were divided by the unit price \$1, giving cost indices, and the abscissas were divided by 1,625, giving

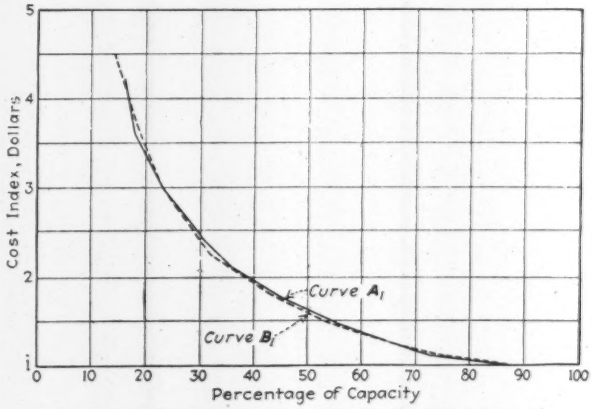


FIG. 2—EFFECT OF CURTAILMENT OF OUTPUT ON YARDAGE COSTS OF CONCRETE

percentages of total capacity. The same procedure was followed for curve B, using the proper corresponding data. These points were then plotted, percentages of total capacity as abscissas and cost indices as ordinates, giving, as shown by Fig. 2, curves A_1 and B_1.

Attention is called to the great similarity between curves A_1 and B_1, even though curve A_1 is obtained from data from a plant of one-half the capacity of that used as the basis of curve B_1. This would tend to indicate that the relations shown by the curves are independent of the size and capacity of the individual plants.

With the curves shown in Fig. 2, it is a simple matter to arrive at the effects of curtailment in output. Assume a normal rate of 100 cu.yd. per eight-hour day at a cost of \$3 per cubic yard. If for some reason or other the output drops to 70 cu.yd. per day, what is the effect on the unit cost? Using the curve, Fig. 2, we find that with a 70 per cent output the cost is 1.15 times the unity cost, or $1.15 \times 3 = \$3.45$ per cubic yard.

The use of the curve has great possibilities in problems where the actual cost of a piece of work is known and it is desired to find the cost of the same piece of work assuming it had been done at a more rapid rate of progress.

Revamping Steel Viaduct to Carry Street Over Railroad

Efficient Use of Old Steel by Refabrication in Near-By Structural Shop—Careful Planning of Work—Some Novel Details

By Theodore Doll and Jack Singleton

Respectively, Assistant Engineer, Bridge Department, A. T. & S. F. Railway, and Chief Engineer and General Manager, Capital Iron Works Company, Topeka, Kan.

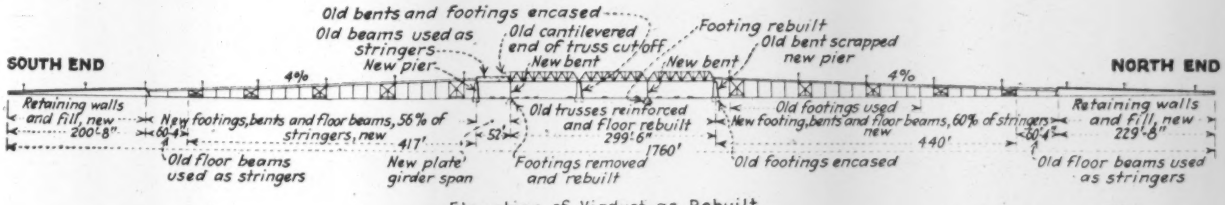
REMODELING a structural steel railroad overcrossing by taking it down, refabricating two-thirds of the old steel and then re-erecting it with this steel and 70 tons of new steel was the unusual procedure required in modernizing the Branner St. viaduct in Topeka, Kan. The viaduct carries a city street over the main line track of the Atchison, Topeka & Santa Fe Railway by means of three 100-ft. trusses and a 52-ft. girder span. Approaches consisting of 225 ft. of retaining wall and fill and approximately 500 ft. of structural steel bent and girder construction lead up to the crossing on each end. During the reconstruction the south approach, which had formerly been at 90 deg. to the trusses, was placed in line with the rest of the structure. The grade of each approach was decreased from 6 to 4 per cent, and the total length of the viaduct was increased about 400 ft. About 300 tons of old steel was taken down, 200 tons of which was replaced.

The old viaduct, erected in 1908, was designed according to Cooper (Class B, 1901) to carry 40-ton street cars and light highway traffic. The new structure is designed according to the 1924 A.R.E.A. specifications to carry three lines of 20-ton trucks.

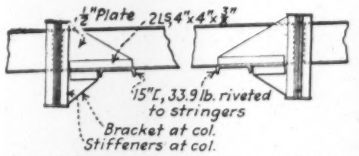
Special care was taken to make the plans complete, legible and accurate and thus to simplify the field work as much as possible. All old material used, as well as new material, was fully detailed and indexed, and all related sheets connected by cross-reference notes. Pieces were duplicated as much as seemed economical, and special details were provided to simplify construction.

Before any of the old steel was taken down, each piece to be re-used was marked in accordance with diagrams and instructions contained in the plans. Each approach was completely taken down in 2½ days, without any injury to the old material, the rivet heads having been cut off in two days with two two-man pneumatic rivet busters. As the steel was taken down, the discarded material was piled up at one side, and that to be re-used was placed on 5-ton trucks and hauled about ¾ mile to the structural shop of the Capital Iron Works, where it was cut and punched in accordance with the details. It was then hauled back and spotted in position on the ground.

The new steel, as it was received from the fabricator, was put in the yard at the structural shop, sorted by panels, hauled to the site in trucks and spotted in position.

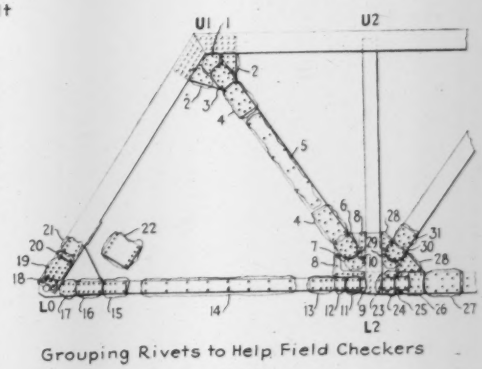


Elevation of Viaduct as Rebuilt



Detail for Bracing Floor Beams Against Tractive Forces by Riveting Channels to Stringers

Length of Rivets					
Group No.	Diam.	Length of Rivets	Group No.	Diam.	Length of Rivets
1	¾	2½	18	¾	2⅜
2	do.	2	19	do.	3
3	do.	3	20	do.	2½
4	do.	3	21	do.	2⅛
5	do.	2¼	22	do.	2¼
6	do.	3	23	do.	3
7	do.	2½	24	do.	2½
8	do.	2	25	do.	3½
9	do.	3	26	do.	3
10	do.	2⅛	27	do.	3
11	do.	3½	28	do.	2
12	do.	2¾	29	do.	2½
13	do.	2¾	30	do.	3
14	do.	2⅛	31	do.	3
15	do.	2½	32	do.	3
16	do.	2½	33	do.	3
17	do.	2⅛	34	do.	2½



Grouping Rivets to Help Field Checkers

FIG. 1—DETAILS OF VIADUCT, TOPEKA, KANSAS, REBUILT TO CARRY MODERN STREET TRAFFIC

The elevation of the viaduct shows the type of structure as well as the extent to which the old steel was re-used in the new bridge. Note also the details showing the method of grouping rivets on the drawings in order to assist in checking the field rivets.

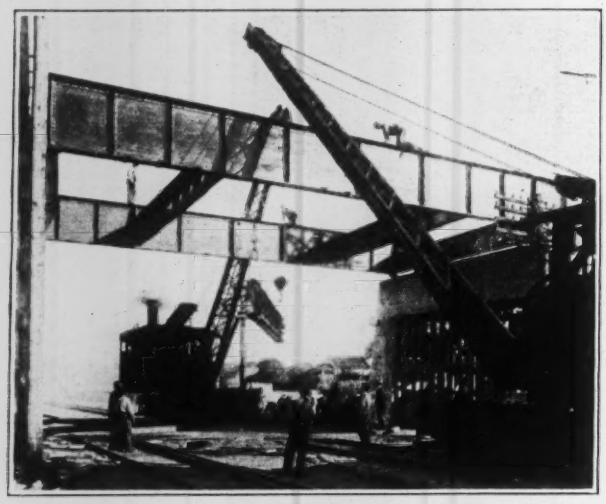


FIG. 2—RAILWAY CRANES WORKING BETWEEN TRAINS TO ERECT GIRDER SPAN

All material at the site was handled and erected by a crawler crane with a 50-ft. boom, except that the girder span was erected by two Santa Fe cranes, as shown in Fig. 2. This span was over the main line and had to be erected between trains.

The old concrete footings were broken up with pneumatic drills. The old retaining walls were drilled for low percentage dynamite, blasted off in sections and then broken into loading size with the drills. The discarded concrete and the filling of the old approaches were loaded on cars for disposal by the railroad, since the filling between the new retaining walls was clean river sand.

Some of the repairs for the truss spans may be seen in Fig. 3. Angles were inserted in the top chord, it being necessary to remove only a batten plate and two lacing bars at one end of each member. Upper intermediate panel points are braced both horizontally and vertically by brackets connected to the floor beams. The pieces in Fig. 3 that appear to be diaphragms between the stringers are blocks to support the form planks for the reinforced-concrete deck.

In order to make a good job of riveting possible on the trusses, reproductions of the detail sheets were used for making rivet-grouping diagrams, as shown in Fig. 1. Although inspectors are sometimes expected to sketch such diagrams on blueprints, the logical and economical procedure is to make them in the drafting room. They are a time-saving help (in this case a necessity) for making and checking the list of field rivets, as well as for the actual work of field riveting.

In the approaches the floor beams were designed to rest directly on top of the columns. When such a beam is loaded, the deflection brings the center of bearing near the inside face of the column and causes eccentric loading if the section is symmetrical. The best type of column for such conditions is one in which the center of gravity is near the inside face. In this case the column was composed of a 12-in. channel riveted to a 10-in. I-beam. The total weight was no greater than that of the lightest symmetrical section that could have been used, the stresses were lower, the fabrication was cheaper and the difficulty of inspection and painting was notably decreased.

Horizontal diagonal bracing was not used, because the reinforced-concrete deck provided ample lateral stiffness. However, in order to eliminate the possibility of bending about horizontal axes through the floor beam webs, due to tractive forces, horizontal beams were provided in the braced panels. As shown in one of the details of Fig. 1, they were simply 15-in. channels riveted to the bottom flanges of the stringers and to rigid brackets at the end stiffeners of the floor beams. Horizontal diagonal bracing could have been used for the same purpose, but it would have required rivets in the bottom flanges of some stringers near the section of maximum moment, would have complicated the detailing and fabrication and would have increased the number of erection marks.

Because of the variety and large number of old beams used for stringers, all connection angles were shipped attached to the floor beams, one-half shop riveted and one-half bolted. The riveted connection angles on adjacent floor beams were on opposite sides of the respective stringers. Since the stringers could easily be swung into place against the riveted angles and be held by drift pins, shelf angles were omitted. The erector found this scheme very satisfactory.

Each of the column base slabs was provided with three tapped holes and bolts for leveling the slabs and for supporting them until the grout had set. Slabs thus

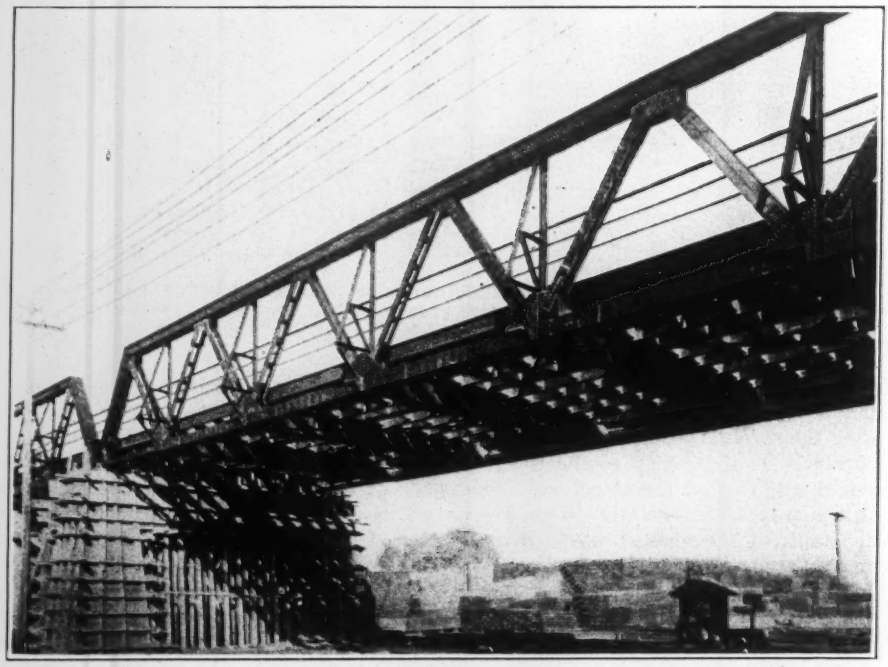


FIG. 3—ONE OF THE REPAIRED TRUSS SPANS
Angles were inserted inside the top chords and reinforcing plates were used on the bottom chords. Note brackets for bracing the upper panel points.

equipped can be set in less than half of the time required by leveling with shims and wedges.

All of the old columns had pockets at the base that had been filled with concrete. The erector knocked the concrete out of several of these pockets and found that the surrounding steel was badly corroded, which indicated that it would be wise to seal the tops of such filled pockets with tar or asphalt. All the rest of the material in the old structure was in good condition, except that the locomotive blast had eaten away part of the bottom flanges of old stringers over the main line tracks.

The remodeled structure was designed and detailed in the office of A. F. Robinson, bridge engineer system, Atchison, Topeka & Santa Fe Railway, under the immediate supervision of Theodore Doll, assistant engineer. The new steel was fabricated by the Missouri Valley Bridge & Iron Company, Leavenworth, Kan. All field work, including both steel and concrete, was done by the Capital Iron Works Company, Topeka, Kan., in charge of Jack Singleton, chief engineer and general manager. Mark Symmes was superintendent of erection, and Tom Perniner was inspector for the A.T. & S.F. Railway.

Diversified Program for Water-Works Fraternity

Engineers, Superintendents, Manufacturers and Fire Insurance Men Take Part in Montreal Convention of New England Water Works Association

DIVERSITY of subject and of interests represented was a feature of the 47th annual convention of the New England Water Works Association, held at Montreal, Canada, Sept. 18 to 21. The papers and committee reports dealt with sources of supply, water treatment, distribution systems and subsidiary topics, including various materials and the controversial subject of cross-connection elimination. All classes of membership participated in the presentation and discussion of papers, several numbers being assigned to the supply men. The superintendents had three sessions all their own, at which many operating problems were discussed with the utmost freedom. At no point was a damper put on the discussion or the latter cut off entirely by an overcrowded program. The business transacted is summarized in the current news section of this issue. The technical proceedings are reviewed in what follows.

Cross-Connection and Other Committee Reports

Of a dozen committees on the program, the only one to do more than submit a progress report was the one on cement-lined pipe, chiefly on the hygienic aspect. For this committee Robert S. Weston, consulting engineer, of Boston, detailed the results of experimental studies conducted in the laboratories of Weston & Sampson on a 100-ft. length of cement-lined pipe, water from which was tested through a period extending over a number of months. This test showed a heavy increase in the amount of alkalinity in the water after it had flowed through the pipe for a relatively short time, followed by a marked decline later on. The committee concluded that there is no hygienic significance in the dissolved matters taken up by the flow of water through cement-lined pipe. Long life of the pipe is indicated both by the test and by samples of cement-lined pipe in use for from 14 to 60 years. The committee suggested that pipe manufacturers give careful consideration to the kind of cement used for linings in relation to the character of water that is to flow through this pipe.

The committee on cross-connection, through Robert S. Weston, advised against present action on its report submitted some months ago and printed in the *Journal* of the association for June. The recommendations of what was designed to be the final report of the committee met with so much criticism last spring that action was deferred, with the understanding that the committee would be free to revise its recommendations before the report again came up for action. Mr. Weston stated that since the committee submitted its report last spring new factors had arisen and that the committee was not at present in agreement. The new factor mentioned by Mr. Weston was the stand-by pump chlorinator, which has been tentatively approved by the New York State Department of Health for use under certain conditions. (See *Engineering News-Record*, July 12, 1928, p. 75.) Mr. Weston raised the question, Will not this device put the auxiliary water supply on the same basis as does chlorination of a regular supply? A spirited discussion on this report indicated a strong feeling on the part of a number of the members of the association in favor of the prohibition of cross-connections, as was the case at the spring meeting when the report was first presented. The report was finally laid over for consideration at one of the fall or winter meetings, with the understanding that it be given consideration then, and the recommendations finally submitted be sent to letter ballot.

Three progress reports were submitted by Frank A. McInnes, consulting engineer, of Boston, chairman of three sectional committees under the American Standardization Committee. Five sub-committees of the committee on simplification of manholes, frames and covers have their reports in the hands of a correlation committee. A number of standards for pipe flanges and fittings have been approved by the committee on that subject; two other standards are nearly ready, and progress has been made on various others (this report seems to have been substantially the same as the one submitted by the sister committee of the American Water Works Association at San Francisco in June; see *Engineering News-Record*, June 21, 1928, p. 967). The general committee on cast-iron pipe and special castings held its third annual meeting at Washington in March and agreed to employ an executive secretary to its chairman, on a half-time basis, with the hope that the American Water Works Association would pay this man for the other half of his time, evidently to serve as a technical secretary to one or more committees of the A.W.W.A. In general, the work of this committee on specifications for cast-iron pipe and special castings, said Mr. McInnes, is progressing as fast and favorably as can be expected in view of the difficulties with which it is confronted. [The committee and its predecessors go back to 1911, and have not yet presented a final report. For tentative drafts of specifications by a majority of one of the earlier committees, see *Engineering News-Record*, May 31, 1917, p. 149.—Editor.]

Various problems pertaining to keeping a water-works distribution system equal to growing demands upon it were described by Fred B. Nelson, assistant engineer, Department of Water Supply, New York City. In a rapidly growing section of the Borough of the Bronx pressure gradient surveys have been made by taking pressure observations at various fire hydrants. From these was deduced the necessity for increased trunk main capacity. Somewhat similar surveys in the Borough of Manhattan to serve the same general purpose have been "useful in locating breaks in mains, open blowoffs, closed valves, or restricted circulation" and to answer complaints as to pressure, including advice on "whether new or larger plumbing will improve conditions." In some areas the problem is not so much one of pressure as of quantity of water available to meet fire demands. To determine the adequacy of the volume of water, New York, as is the case in other cities, makes hydrant-discharge tests by selecting "a group of hydrants" for "simultaneous discharge" and checking up at a hydrant either near or in the group that is supposed to draw water from a different direction.

Distribution problems from a different viewpoint were taken up by V. Bernard Siems, formerly water engineer of Baltimore, Md., and now vice-president and engineer, Detwiler & Company, New York City. The paper was based largely on studies by Mr. Siems while at Baltimore, supplemented by later studies of water-works in other cities. Among the primary considerations are whether the main use of water in a given district is domestic, industrial or mixed, and if the latter, whether industrial or domestic will finally be likely to dominate. In these studies zoning regulations, if in existence, are helpful. The growth of metropolitan districts adds to the many distribution problems.

Recent Developments in Water Purification

The most significant of the recent changes in water treatment, said Wellington Donaldson, of Fuller & McClintock, New York City, "are not so much new design features as the modified use of purification facilities already available along the lines of coagulation, softening and chlorination." Indications are that, instead of simplification, processes of treatment are "becoming more complex and more highly specialized."

Mechanical cleaning of settling basins, first taken over from metallurgical work and applied to the voluminous precipitates of the lime and soda ash processes, have been extended to coagulating and settling basins of filtration plants, and the basins have been changed from circular to rectangular form. As yet, practice has not been standardized here—nor in mixers for distributing chemicals in softening or in coagulating plants. Lack of flexibility in baffled mixing chambers has led to the trial of "clarifiers" or mechanical stirrers and to the use of tangential bottom inlets. The "hydraulic jump" as a mixer has been used at the new 165-m.g.d. Cleveland plant and elsewhere. Most of the newer types of mixing devices appear to be working satisfactorily, with advantages over the earlier types.

In filter design there have been no important recent changes. In such appurtenances as gages and controllers there is considerable diversity, "but nothing particularly novel has developed" in the last year or so except "the substitution of electrical instruments at Wausau, Wis., for the usual filter flow gage."

Chlorination is expanding. Many plants use split chlorination—"treating both raw and filtered water where heavy bacterial loading exists." A recent convert is the Hackensack Water Company (N. J.), which applies 0.5 p.p.m. of chlorine at the coagulation basin inlet and 0.15 p.p.m. to the filter effluent. At Kansas City, Kan., a second dose of chlorine is used to control algal growths in a distributing reservoir. Superchlorination, followed by the use of sulphur dioxide or some other anti-chlor, first used in North America by Howard at Toronto, is used nowhere else on this continent, so far as Mr. Donaldson knows, except at Rahway, N. J.

Softening of municipal supplies has been given an impetus by the use of recarbonation to obviate incrustation. Zeolite for softening is used at seven municipal plants in this country, but except for the 4-m.g.d. plant at McKees Rocks, Pa., the installations are small—0.2 to 0.2-0.04 m.g.d., but at Sewickley, Pa., a 2-m.g.d. plant is nearing completion, notable for following ordinary rapid sand filter design.

In the discussion of this paper Charles W. Sherman, of Metcalf & Eddy, Boston, objected to the use of the term "clarifier" as applied to settling reservoirs as being incorrect nomenclature. Robert S. Weston supported the objection and suggested that "mechanically cleaned basin" is a preferable term. Mr. Donaldson, author of the paper, agreed with these criticisms and suggestions. Prechlorination, said Norman J. Howard, chemist of the water-treatment works at Toronto, Ont., is now being used by some 30 cities in the United States and Canada. Prophylactic treatment of water with copper sulphate to prevent algal growth is in practice continuously at Norfolk, Va., said Robert S. Weston. The amount of copper sulphate used is small.

Protection of Water Catchment Areas

A review of what is commonly spoken of as the sanitary protection of water supplies was presented by John F. Skinner, assistant city engineer in charge of additional water supply, Rochester, N. Y., and was followed by a somewhat extended discussion. In the case of surface water supplies, protection depends largely upon the use and size of the catchment area, the volume of storage in relation to consumption, and the slope of the land. Small settlements on shores should be purchased and eliminated. More distant population on drainage areas should be dealt with according to a variety of conditions. It may even be necessary to build sewage-works. As to land purchase, this may range from a strip 100 ft. wide around the shore of the reservoir to thousands of acres. Use of both the reservoirs and the catchment areas for various recreational purposes presents a variety of problems, with recreational health interests more or less in conflict. The consensus among those who discussed the paper was in favor of much restriction, if not complete prohibition, of hunting, fishing and boating, but recognition was given to the fact that while heavy restrictions may be possible in the case of small reservoirs and small drainage areas, they may be wholly impracticable on very large ones, so that the chief restrictions in the latter case would have to supply points relatively near the water-works intake.

Superintendents Have Three Sessions

On Wednesday the program called for two parallel sessions, morning, afternoon and evening, one general and the others devoted to superintendents' problems. The two evening sessions were combined, the super-

intendents waiting until after the presentation of two papers on the Montreal water-works. The main topics laid before the superintendents were Distribution, Electrolysis of Water Mains, and the Effect of Flushometer Valves in Water-Works Practice, and the Use of Copper and Brass Service Pipes. The discussion on distribution problems was opened by Fred B. Nelson. Abstract of his paper and of one on distribution system design, by B. V. Siems, are given on p. 476.

The discussion on electrolysis of water mains was opened by Mr. Baron, who described electrolysis survey methods followed by Albert F. Ganz. This topic, also one on grounding electric wires on water service connections, brought out a long discussion, which for the most part followed the lines of earlier discussions of electrolysis before the leading water-works associations, but on the whole seemed to indicate that electrolysis is not so serious a problem as it was some years ago. This appears to be due, at least so far as electrolysis of mains is concerned, to the provision of better means for returning stray currents from electric railways to power stations and to the fact that some electric railway lines have been discontinued.

As is customary when discussion lags at water-works superintendents' conferences, some one raised the question at Montreal, whether the manufacturing plants should pay for private fire protection service. Plenty of discussion resulted, but little was brought out that has not been said again and again.

The question as to the use of flushometers also stirred up much discussion but added little to what has been said on both sides of this question many times before. Conclusions to be drawn from the Montreal discussion were that the use of flushometers leads to a demand for services and meters of increased size, but this need not cause much worry if fixed charges for services and meters are increased accordingly—which often results in accepting smaller services and meters than were originally requested.

A paper not on the program, dealing with use of service connections of brass and copper, was presented by Mr. Schneider, of the Copper and Brass Research Association. Practically all the discussion on this paper, based on experience covering from two or three to seven years, favored the use of copper and brass. The only dissenting voice was that of D. A. Heffernan, superintendent of water-works, Newton, Mass., who related very satisfactory experience with cement-lined iron or steel pipe extending over many years.

Manufacturers Given a Place

Several papers designed to give manufacturers and supply men a hearing were scheduled. One of these, entitled "A New Pipe for Water Mains," by R. W. Mitchell, consulting engineer, Asphalto-Concrete Corporation, New York City, described centrifugally made concrete pipe with an inner surface of asphalt. During the convention an inspection trip was made to a licensee under this process, the Consolidated Pipe Company, Ltd., of Montreal. The process is said to have originated in Scotland and to be controlled in the United States and Canada by Manning, Maxwell & Moore.

Another paper in this general group had as its title "The Oxy-Acetylene Process in Modern Industry" and was presented by R. W. Boggs, of the Linde Air Products Company, New York City. The paper was devoted largely to "procedure control," including methods of selecting and keeping check on welders, inspection and tests and welding technique.

Speaking on the topic, "Are the Present Specifications Dealing With Fire Hydrants and Valves, With Special Reference to Valve Stems, Satisfactory?" F. A. McInnes, who had been selected to open the discussion, expressed the opinion that it would not be surprising if they were unsatisfactory in view of the fact that the A.W.W.A. specifications were adopted in 1916. If a revision were to be attempted, Mr. McInnes thought it should be taken up by the American Standards Committee. Mr. Le Count, of the Factory Mutual Companies, stated that a "uniform specification," calling for a twisting test, had been in use for some years. After considerable discussion, most of which seemed to indicate that the various speakers felt no particular need of revision, a standing vote was called for on asking the American Standards Committee to take up the subject. With some 40 to 50 present, only eleven stood up, and of these two were against the proposed action.

Enlargement of Montreal Water-Works

How the plant of the Montreal Water & Power Company, recently purchased by the city of Montreal, has been tied into the old municipally owned works was told by Charles J. Des Baillets, chief engineer, Montreal Water Board, in a paper on the McTavish St. pumping station. The company pumping and filtration plant has been abandoned. The main pumping is being done at the McTavish St. station, which is being enlarged by adding electric driven pumps. The additional filtration plant for the Montreal water-works was described in a paper by Frederick E. Field, division engineer, Montreal Water Board. The new filters will have a rated daily capacity of 120 U.S. m.g.d. compared with 60 U.S. m.g.d. for the plant put in operation in 1918. The latter was a combination of prefilters and slow sand filters, operated without coagulation. The new filters will be of the rapid sand type with a strainer system similar to that in the old prefilters, and also with no provision for coagulation. During 1927 the final or slow sand filters of the old plant operated at a rate of 13.7 U.S. m.g.d.

Greenwich Water Company Extension

Additional sources of water supply and provision of a treatment plant for the Greenwich Water Company, which supplies Greenwich, Conn., and Rye, N. Y., was the subject of a paper by Dana M. Wood, of Stone & Webster, engineers, Boston, and E. Sherman Chase, of Metcalf & Eddy, consulting engineers, Boston, the latter having been engaged as engineers on treatment. Additional storage of surface water to increase the possible daily supply from 6 to 47 m.g.d. is included in the plan for future development. It is proposed to install two 8-m.g.d. electric driven pumps, to bring a rapid sand filtration plant capacity up to the same rate, and to provide a 24-in. centrifugally cast cement-lined supply main.

Gasoline Tax for Road Development in India

A road development tax of approximately 4c. on every gallon of gasoline produced in or imported into India has been recommended by the roads development committee in a report recently submitted to the Indian government, according to advices from Vice-Consul Winfield H. Minor, Calcutta, made public by the Commerce Department.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Automatic Pipe-Break Valves on Mokelumne Aqueduct

TO PROTECT the 54- to 65-in. steel pipe aqueduct of the East Bay Municipal Utility District, extending from the Pardee supply reservoir on the Mokelumne River 94 miles to Oakland, Calif., four automatic shutoff valves and blowoffs have been installed in the pipe line, which will go into action in the event of a break in the pipe. In case of a break of the pipe downstream of one of these valves, the increased rate of flow through the valve will automatically operate a motor-driven closing mechanism, shutting a butterfly valve in the pipe and thereby preventing further flow into the broken section; at the same time, to avoid the rise of pressure on the supply side of the shutoff—since on stopping the flow the pressure would at once build up to static head in place of the much lower head to the hydraulic grade line—and thus make it unnecessary to provide the extra strength in the pipe needed to resist this greater head, a wasteway or blowoff just above the shutoff valve is opened simultaneously with the closing of the shutoff, in such a way as to maintain the rate of flow through the upper portion of the aqueduct substantially normal and thus keep the head down to the hydraulic grade line.

The nature of this protective mechanism, the general arrangement of which was suggested by F. W. Hanna, chief hydraulic engineer of the district, and which was worked out in detail by the Pelton Water Wheel Company of San Francisco, is shown in Fig. 1, where the working parts are set up independently of the pipe. Fig. 2 shows one of the completed installations and indicates how the shutoff valve is mounted at the throat of a double-tapered pipe section or Venturi-meter-like arrangement. The pressure difference between the entrance and the throat of the tapered pipe is utilized for actuating the closure and blowoff mechanism.

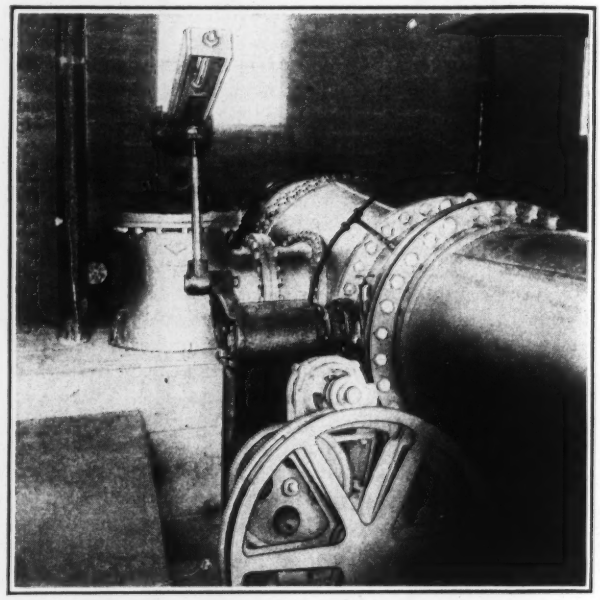


FIG. 2—PIPE-BREAK VALVE AND BLOWOFF
The valve is covered by a concrete protection house which straddles the aqueduct line.

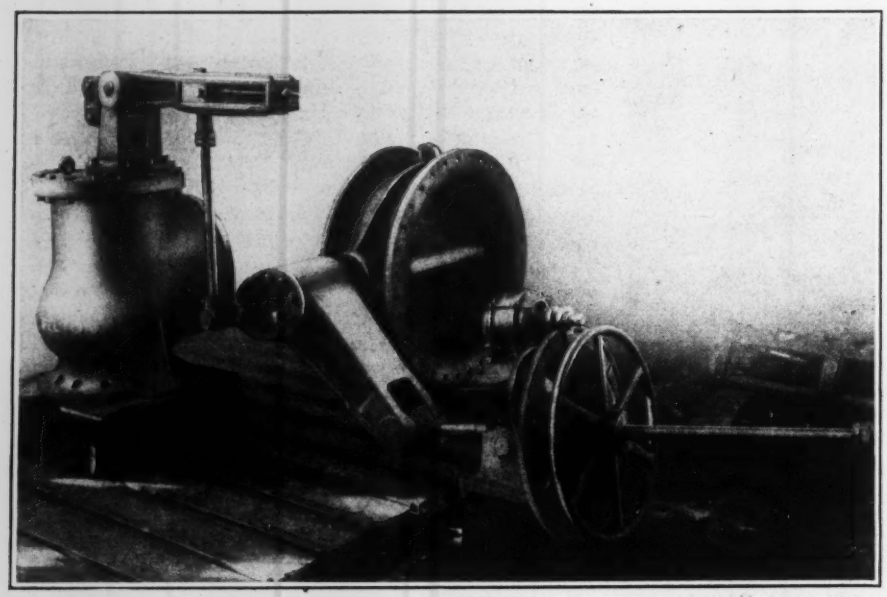


FIG. 1—WORKING ELEMENTS OF MOKELUMNE AQUEDUCT PIPE-BREAK VALVE AND BLOWOFF
The butterfly valve forms the pipe closure and is installed at the throat of a double-tapered pipe section. At the left is the blowoff, which is connected to the supply side of the tapered section. The flange on the far side of the blowoff is bolted to the pipe, while the blowoff outlet is below. A balanced needle valve controlled by a pilot valve operates the blowoff. The pilot valve is linked to the operating arm of the butterfly shutoff. The mechanism is operated by an electric motor controlled by a relay-operated switch. The contact-making cam of the relay is thrown by the movement of a float in a differential mercury column, of which one side is connected to the entrance end of the tapered-pipe section and the other to the throat.

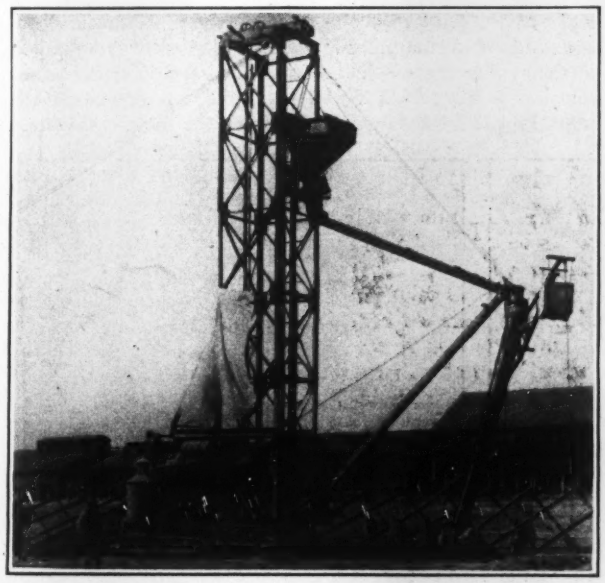
A differential mercury column has one side connected to piezometer inlets at the entrance to the tapered-pipe section, while the other side is connected to similar inlets at the throat. The two legs of the mercury column will therefore assume different relative elevations as the velocity of water flowing in the pipe is varied. A float in the mercury column is arranged to throw a cam controlling electric relay points, and when the velocity through the pipe reaches a certain value the relay contacts are thereby closed, energizing a solenoid switch which supplies power current

to the motor operating the valves. This motor slowly throws the arm of the butterfly valve, closing it, and through linkage connected to this arm also shifts a pilot needle in the blowoff. Through the pilot valve the main needle valve controlling the blowoff is opened, which allows the water in the supply end of the pipe to discharge downward through the blowoff to a wasteway.

These valves have been installed at Bear Creek, about 8 miles from Pardee reservoir; San Joaquin River, 35 miles; Indian Slough, 48 miles; and Clyde Wasteway, 74 miles from the reservoir. Adjustment of the blowoff to the movement of the shutoff valve is provided for by screw adjustment in the connecting linkage, and hand switches are included in the electric circuit so that the motor may be stopped in any desired position or may be caused to close the valve independently of the float-operated relay. A manual reverse switch also is included for opening the shutoff and restoring normal flow.

Paver Equipped With Tower Pours Buffalo Pier

IN BUILDING the new municipal pier for the city of Buffalo, N. Y., the problem of concrete distribution was important because of the large area over which the work was spread. The contract called for 4,400 ft. of wall in two docks, each 1,200 ft. long. One dock was 100 ft. wide and the other 220 ft. The construction plant adopted consisted of a standard 27-E paver with boom and bucket replaced by a 40-ft. tower, elevating bucket, receiving hopper and boom chute all supported on the paver and a two-wheeled truck. This equipment combined the advantages of tower chuting with the advantage of portability. The concrete was poured in three months. Incidentally, the work was completed in a year, as compared with the contract time limit of two years. The Monarch Engineering Company, Buffalo, was the contractor. According to the T. L. Smith Company, Milwaukee, builder of the concreting plant, similar units have proved extremely useful on larger sewer work and on the recent addition to the Galveston sea wall.

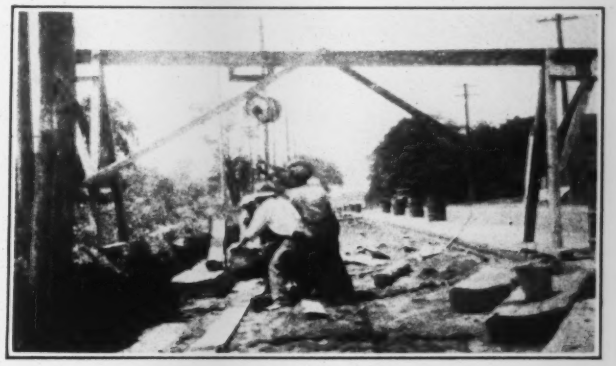


PAVER WITH MOUNTED TOWER POURS BUFFALO PIER

Salvaging Old Concrete Curb in Widening Cleveland-Buffalo Road, Ohio

By H. P. Chapman
Engineer Inspector, Department of Highways, Columbus, Ohio

A GANTRY frame and a chain hoist which are being used in taking up and shifting concrete curb are shown by the accompanying illustration. The pavement is on the Cleveland-Buffalo road in Lake County, Ohio,



CHAIN HOIST ON GANTRY FRAME SHIFTS OLD CONCRETE CURB

and it is being widened 14 ft. with brick on a concrete base. The old curb is 12 in. deep and 21 in. wide and is dished on top to form a gutter. It was built in 7-ft. lengths, which are separated and shifted one at a time.

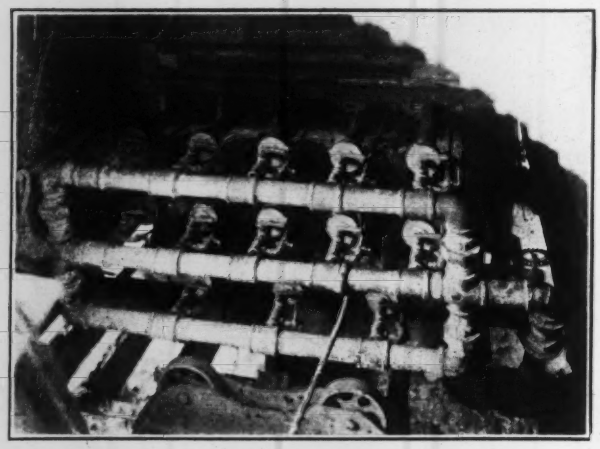
A small batch of 1:8 concrete is mixed and placed on the subgrade at the new location of the curb to serve as a bed. Then the old curb is picked up with the chain hoist and moved to its new resting place. There has been no difficulty in getting a good line and grade, and the breakage has been less than 2 per cent. Five men and a foreman can reset 400 to 500 ft. a day.

Gas Fuel Increases Asphalt Output With Portable Plant

COMMERCIAL gas fuel for drying and heating aggregates and for generating steam are being profitably employed at the Toledo (Ohio) asphalt paving plant of the H. P. Streicher Company, Inc., general paving contractor. Both oil and natural asphalts are employed, and an average of a carload a day is used during the paving season.

The plant consists of a 1-ton mixer, a 30-ton drier, two 40-ton kettles, two 125-hp. boilers, one 20-ton storage tank and their appurtenances, all mounted on railway car trucks. On the ground there are three 50-ton and one 150-ton steel tanks for asphalt storage. The combination heater and mixer is 65 ft. long, 12 ft. high and 8 ft. wide. The sand and gravel drier in the form of a long revolving drum sets well down in the frame, while above it are located two asphalt kettles, each holding 20 tons. Separate weighing bins are located on a stand 25 ft. high; one is for weighing sand and gravel and the other is for measuring the asphalt. These two measures, dumped into a common bin with revolving paddles, constitute a ton batch and are mixed together. The mix is then dropped by gravity into motor trucks and delivered to the job hot.

The drum in which the sand and gravel is dried is heated with thirteen atmospheric gas burners. The two



GAS BURNER INSTALLATION FOR SAND AND GRAVEL DRIER

boilers in the steam plant are fired with five and three gas-tube burners respectively. The asphalt is melted in the kettles by steam forced into pipe coils laid in the bottom. As it comes solid in the cars, similar pipe coils are used to melt it when it is pumped into the storage tanks. More steam coils are required to keep it melted in the storage tanks.

Prior to the utilization of gas both coal and oil had been used. With coal the plant has handled as much as 126 tons daily and with oil the best record was 235 tons a day. Since gas was installed, the plant has averaged 325 tons daily throughout an entire job. During the four months of July, August, September and October, 1927, the plant handled 6,700 tons of asphalt with a consumption of 8,000,000 cu.ft. of gas, or at the rate of 1,280 cu.ft. per ton. Absolute heat control is maintained with the aid of a recording pyrometer.

Self-Dumping Scow Turns Completely Over

A SCOW of 500-cu.yd. capacity dumped by flooding eccentric compartments is being used in Puget Sound by the Pioneer Sand & Gravel Company, of Seattle. It is said the scow will dump its full capacity in five minutes. Both top and bottom of the scow are identical so that each deck can be loaded and the scow turned over and over as load succeeds load. The valves operating the flooded compartments can be operated by a trip rope from the tugboat.

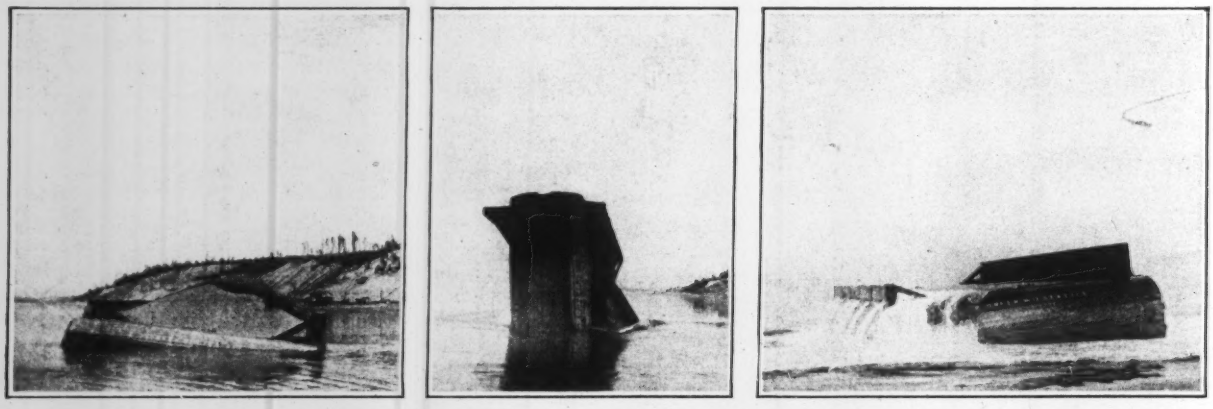
The scow is of the usual rectangular type, made either of wood or steel. The one used in Puget Sound is 100 ft. long, 36 ft. beam and 11½ ft. depth. Braced bulwarks, about 4 ft. high, run the length of both top and bottom decks. When loaded, the scow draws about 14½ ft. of water. It is divided lengthwise internally into two halves, each the same except that each half is upside down in relation to the other. Each half is composed of two horizontal compartments, one smaller airtight compartment, and one larger flood tank with two 8-in. valves giving a vent to each deck. When ready to dump, the valves are opened on that side of the scow in which the flood tank is underneath the air compartment. As the flow tank fills, the scow settles on that side until the overbalancing effect is sufficient to cause the scow to turn over. The airtight compartment now being on the bottom and the top of this compartment being above the light draft line, the water drains out through the flood valves. While the barge is being towed back to the loading berth, the scow drains itself and is ready for another load.

From Job and Office

Hints That Cut Cost and Time

Building Covering 66,600 Sq.Ft. Completely Welded in Field

AN AUTOMOTIVE shop for the Associated Oil Company in Emeryville, Calif., with a roof area of 66,600 sq.ft., supported on 52 trusses of 60-ft. span, has recently been completed, all welding being done in the field. According to a paper presented before the San Francisco Section of the American Welding Society, as reported in the *Journal* of the society for July, A. B. Villadsen, of Villadsen Brothers, Inc., which had the contract, stated that all steel was brought to the job cut to length. Beside the building site a platform was built with 10-ton derricks at two sides. Two templets in the shape of the trusses were placed on the platform and the truss members clamped to them. The work was arranged so that while the welders worked on one truss the other was being assembled for them; while they welded the second truss the first was lifted from the templets, turned



OPERATING VIEWS OF SELF-DUMPING SCOW

Left-hand view shows loaded scow with right-hand flood compartment filling. In the center view the scow is just turning over, while in the right-hand view dumping action is complete and the scow is ready for another load.

From Job and Office

For Contractor and Engineer

over and laid on the platform outside the templet and the remaining members fastened with iron clamps awaiting the welders. Thus there was no lost time in the operations. The trusses were made of structural angles and channels. Before starting erection, base plates for the columns were set to exact level and after the trusses and columns were erected, lined up and plumbed, the bottoms of the columns were welded to the base plates. This is reported to have given a perfect bearing for the ends of the columns, which were not milled. There was only one bolt hole in the trusses, and this was used for erecting purposes.

Earth-Embankment Guard Rails on West Virginia Roads

By B. E. Gray
Division Engineer, State Road Commission, Keyser, W. Va.

EARTH-EMBANKMENT guard rails are being employed with marked success on some of the state roads of West Virginia. At first these guard rails were

FIG. 1—EARTH GUARD RAIL MARKED TO INSURE VISIBILITY

built by the maintenance forces using the material which had sloughed off the slopes and banking it on the outside edge of the roadway. They were made approximately 6 ft. wide at the base and 3 ft. high with a 1 on 1 slope on either side. During the past year the embankments have been designed integral with the cross-section of new-graded earth roads and are costing about 20c. per linear foot to build. The costs of such mounds built by state maintenance forces have varied from 10c. to 30c. per linear foot. The cost of wood and cable guardrail is from 50c. to 75c. per linear foot, so that, when first cost and maintenance cost are considered, the earth embankment is much cheaper.

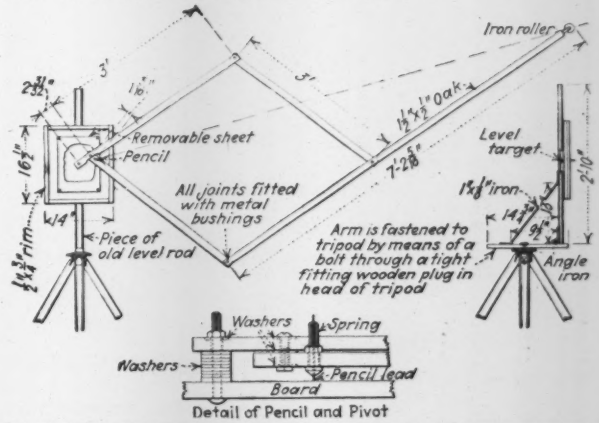
These guard rails have the advantage of being permanent to a large degree and of permitting a moving vehicle to run into and upon them with less frequent injury to the vehicle and with almost a universal turning back of the vehicle onto the roadway without overturning. One of the objections raised against the type, however, has been lack of visibility at night, in which particular the white painted post excelled. This disadvantage has been overcome by two methods. By one the inner slope of the earth mound is covered with white sand or lime-

FIG. 2—EARTH EMBANKMENT GUARD RAIL GRADED INTEGRALLY WITH ROADBED

stone and by the other stripes are either whitewashed transversely to the center line of the road on the face of the mound or sand is used in the same manner. The views show the results of such treatment and the shape and location of the embankment.

Graphical Cross-Sections Recorded by Tunnel Pantograph

A GRAPHICAL representation of tunnel cross-sections without measuring and plotting is quickly and easily obtained by use of a tunnel pantograph as detailed in the accompanying illustration. The instrument shown produces diagrams on a 30 to 1 ratio, and was used in a 12½-ft.-diameter horseshoe section of the Cobble Mountain diversion tunnel, Springfield, Mass., water-supply system. To use, the pantograph is set to line and grade at right angles to the tunnel center line at every point where a cross-section is desired. A fresh sheet of paper, cut out at the center to slip over the pivot pin, is used for each set-up. Rotating the pantograph in a vertical plane with the tip in constant bearing against the tunnel perimeter will accurately reproduce the section to scale on the paper, except across the bottom portion, where the tripod legs interfere with the pantograph arm. By superimposing a tracing of the standard tunnel section over the diagram obtained from the pantograph, the visual relation of the actual and theoretical sections is shown. Areas of the pantograph diagram can be secured by the use of a planimeter. H. H. Hatch, resident engineer of the Cobble Mountain tunnel, built the pantograph with the help of his engineering staff.



PANTOGRAPH FOR RECORDING TUNNEL CROSS-SECTIONS

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

High Rainfall Rate at Newberry, Mich.

Sir—The note on a record-breaking rainfall at Washington, D. C., published in *Engineering News-Record*, Aug. 30, 1928, p. 330, having been brought by me to the attention of John Brown, local co-operative observer, U. S. Weather Bureau, at the State Hospital, Newberry, Mich., he gave me the following data on precipitation that occurred there on Sept. 15, 1920:

A total of 3.26 in. of rain fell in three showers. The heaviest of these showers was between 11 a.m. and 12:15 p.m., when 1.94 in. fell, giving a rate of 1.55 in. per hour. In the storm mentioned in the opening sentence 2.25 in. fell in 1½ hours, a rate of 1.5 in. per hour. Merriman's American Civil Engineer's Handbook, 4th ed., p. 1593, gives a maximum 60-minute rate at Washington, D. C., of 1.78 in.

Newberry, Mich.,
Sept. 5, 1928.

R. R. RYAN,
Chief Engineer.

Depreciation Factor in Automobile Mileage Costs

Sir—I was pleased to note in *Engineering News-Record* Aug. 16, 1928, p. 256, the comment by F. Lavis on my article, "Effect of Distance on Automobile Operating Costs." Mr. Lavis considers 6c. per car-mile the proper average figure to use in estimating passenger automobile mileage costs. I suggested 3c. per car-mile.

Prices throughout the country vary but little. The commodity costs used in my analysis are not subject to great variation and the average mechanical performance cited will, I think, be accepted generally as conservative as applied to the average well-maintained state road. Performance figures are substantiated by records kept for the past seven years on several hundred state cars and are lower than the claims of the car manufacturers.

Therefore I suspect that the great difference in our estimate figures may lie in our treatment of depreciation. I believe that in general the difference in distance involved in alternative modern highway locations does not appreciably affect passenger car depreciation, which is a time item. Two principal reasons support this belief:

1. An automobile is so constructed that for all practical purposes its parts can be renewed and the car kept in service indefinitely. The mechanical depreciation involved which is affected by mileage therefore comes under the head of maintenance.

2. The term depreciation as applied to road costs refers not to a theoretical absolute potential value, but to a definite market or salvage value. This value depends almost entirely on the age of the car, as reference to the turn-in or resale charts of any automobile agency will show. It is the change in this value as affected by age (time) that touches the public pocketbook and leads to the resale or even to the complete scrapping of old cars.

Depreciation on a passenger car may range from 1c. to 10c. per mile more or less depending on its use, but I believe that *in the general case* application of this cost to alternative location estimates is incorrect. Distance saved by an ordinary relocation will not reduce annual depreciation. Consider two cars of identical model each making a daily trip between the same two points but by different roads both paved with concrete but one being one mile longer than the other. Actually at the end of a year the total depreciation on each car will be equal, but the car traveling the *shorter* road will show the greater depreciation per mile. Reduced distance has increased unit depreciation cost! This paradoxical result, which offhand seems absurd, simply illustrates the fallacy of trying to define depreciation as a mileage item. The only stable basis on which ordinary automobile depreciation can be measured is time. Theoretical depreciation savings cannot, with business soundness, be capitalized to justify additional expenditures on such relocations or alternatives.

I hope that more highway engineers will discuss this subject, as it really has an important bearing on our enormous highway program.

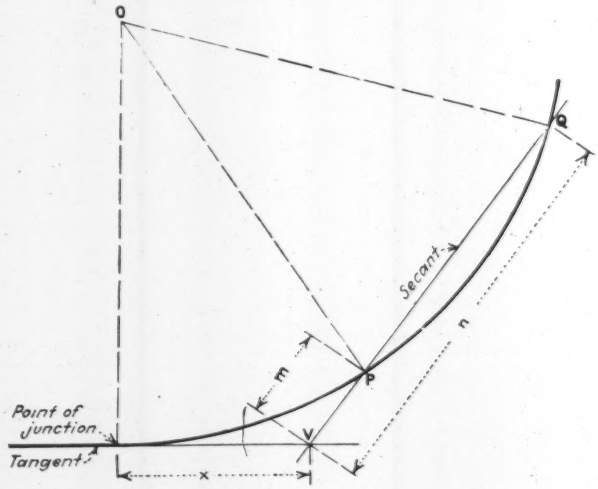
Sacramento, Calif.
Aug. 25, 1928.

N. D. DOUGLAS,
Assistant Engineer,
Division of Highways.

Locating Junction of Tangent and Curve Lacking Original Data

Sir—Herewith is a more simple method than the one described in Mr. Hubbell's article "Locating Junction of Tangent and Curve Lacking Original Data" published in your issue of Aug. 9, 1928.

Select two known points P and Q located on the given curve. These two points determine a secant intersecting



the given tangent at point V. The two secant segments m and n are measured. The length of tangent x, the distance between point V and the desired junction point, is computed from the equation $x^2 = m\,n$.

This formula is based on the known geometrical relation between a tangent and a secant running from a point to a circle. The length of tangent is a mean proportional between the segments of the secant.

This method saves one field measurement and also simplifies the computing considerably.

Brooklyn N. Y.,
Aug. 22, 1928.

J. A. LENECEK,
Assistant Engineer,
New York City Board of Transportation.

Estimates of Earth Pressures

Sir—A striking illustration is afforded of the conservativeness of engineering assumptions in design as between the data given in two articles appearing in the Aug. 16 issue of *Engineering News-Record.*

On p. 250, in determining the combined water and earth pressure against the masonry portion of the Boyds Corners dam, the earthfill, in place nearly 60 years and without doubt placed and compacted with care, is assumed to exert a pressure equivalent to that of a 92-lb. liquid. In the same issue, p. 235, pressures obtained in the deep cofferdams of the Hudson River bridge, surrounded by the soft Hudson River silt, were as follows, to quote: "The results of the data compiled showed that below the level of the submerged backfill the actual pressures were less than hydrostatic, while above this level they coincided with the hydrostatic pressure."

We have here two examples of full-size and large-size experiment and an opportunity of furnishing the engineering profession with information of great value. It is hoped that both the Boyds Corners dam data and those of the Hudson River bridge cofferdams will be published in detail.

Somerville, Mass.,
Aug. 21, 1928.

J. ALBERT HOLMES.
Hydraulic Engineer.

News of the Week

Uncompleted Lafayette Rolled-Fill Earth Dam Damaged by Movement

About Half the Yardage in California Dam Shifted Position—Embankment Had Been Built to 120 Feet—Cause to Be Sought Through Foundation Studies

STAFF REPORT BY N. A. BOWERS
Pacific Coast Editor, Engineering News-Record

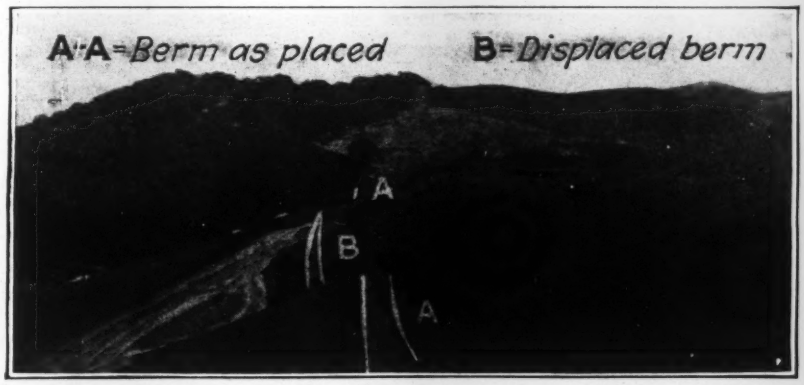
SUBSIDENCE amounting to about 20 ft. at the center of the dam and a shifting downstream of many thousand cubic yards last week stopped construction on the Lafayette dam in California and has raised serious question as to whether the foundation can be utilized for a dam of the height contemplated. The structure is a rolled-earth fill designed for a height of 140 ft. and built to provide a storage and equalizing reservoir on the East Bay Municipal Utility District's Mokelumne project. It had been carried to a height of 120 ft., and 1,709,000 cu.yd. of material, or about 94 per cent of the ultimate yardage, had been placed when the movement occurred. No ponding was used in the placement of material and only a very small quantity of water was in the reservoir.

Subsidence was first noticed in the form of cracks in the well-compacted material at the top and along the downstream toe. The major part of the movement occurred in about three days, but on Sept. 23, six days after the major subsidence, slight movement seemed to be continuing. After the first settlement, excavation with power shovels was begun high up on the downstream face with a view to relieving the pressure until the best means of stabilizing the foundation could be determined. However, when the movement continued and became a major disturbance of the material in the dam, all construction was stopped. The board of directors of the district is considering retaining a board of consulting engineers to pass upon the question of repair of the dam.

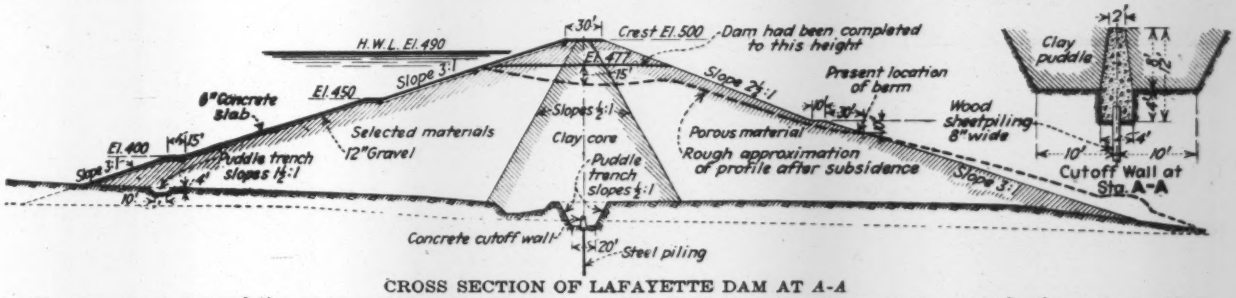
The material in the dam is dry and very solidly compacted. Where the fill has been disturbed the slopes are standing vertically with no tendency to slump, even in the excavation made on the downstream face after the movement. In short, the dam was built with notable care, in accord with exhaustive specifications, and there appear to be no fault planes or similar weaknesses within the structure itself.

Borings made on the dam center line prior to construction were in all cases carried into the Orindan formation, which was encountered at various depths ranging up to a maximum of 91 ft. These borings indicate an alluvial deposit of clay, frequently including sandy or gravelly content, overlying the firm Orindan clay, which constitutes the basic formation in this region. This formation is described in the geologists' report as "of sedimentary origin, composed of a large number of strata of conglomerate, coarse to fine standstone, usually with a clayey matrix, sandy clay, clay

GLACIER-LIKE CREVASSES ON THE DAM TOP
Well-compacted material at the top cracked deeply, like glacial ice, along the line of the 15-ft. subsidence.



VIEW ALONG DOWNSTREAM FACE AT BERM
Marks indicate displacement of berm at center. Note cracks in upper right. The gaps below the shifted berm were made by steam shovels.



CROSS SECTION OF LAFAYETTE DAM AT *A-A*
Showing stage of completion and, roughly, new downstream profile. Some joints in upstream paving opened, others were buckled or crushed.

LOOKING ALONG TOP OVER PART THAT SUBSIDED

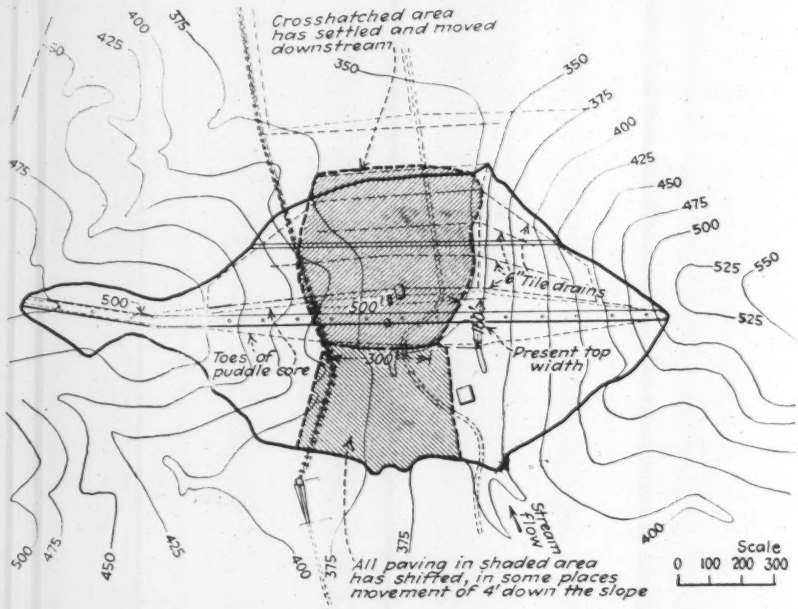
Where the man stands the top is 15 ft. below the immediate foreground. Lateral movement indicated by displacement of A-frame behind the man. It formerly lined up with the two marked *A*.

and occasionally volcanic tuff." Contact with tight formation was made all along the dam center line either by means of a concrete cutoff or the steel sheet piling driven beneath it in the streambed. The watertable in the valley is 20 to 30 ft. below ground surface.

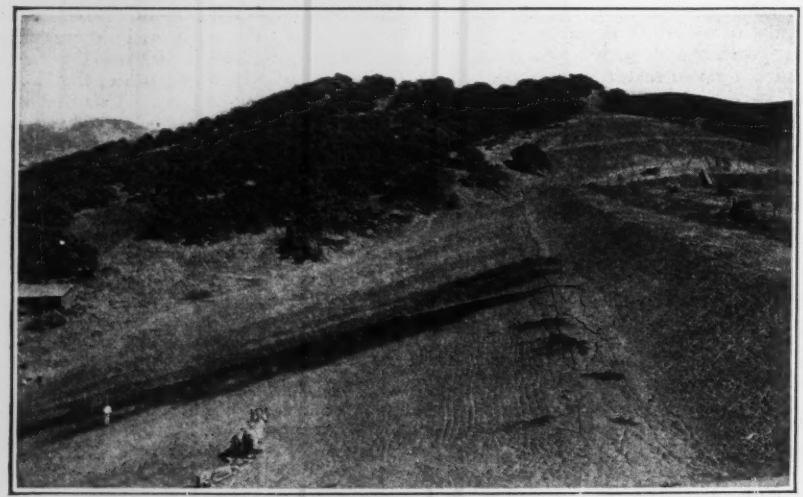
With reference to the suitability of the foundation, conclusions in the geological report on the site by George D. Louderback include the following: "Topographically the basin is excellent for a reservoir and dam site, and the formations underlying the soil and alluvium are satisfactory from the standpoint of structure and low permeability. Percolation through the alluvium of the valley floor at the dam site should be guarded against, also the sliding effects of the Orindan clays at the dam site.

Other than within the puddle trenches, preparation for the foundation consisted of stripping to a depth of 1 to 4 ft. and then plowing with furrows 1 ft. deep and 5 ft. apart. Over the surface thus prepared materials were deposited in layers, wetted down with hose and thoroughly compacted with trucks, rollers and petrolithic rollers. Materials were classified in three groups—namely, specially selected clay for the central puddle section; clay loam and sand for the upstream side, and loam, clay and gravel or stone for the downstream side. The average weight of the fill was about 124 lb. per cubic foot.

The 6-in. concrete paving on the upstream slope had been laid as the work advanced, and was completed to near the top of the fill. This paving is in 50x100-ft. slabs separated by asphaltic compound filler. While the upstream portion of the dam did not undergo the extensive movement that occurred on the downstream side, and although the concrete slabs have not bulged outward or broken extensively within themselves, yet there was considerable movement in the paving, shown chiefly at joints. In the central portion the slabs moved down the slope 4 or 5 ft., with marked buckling on the lower berm. Joints running up


Crosshatched area has settled and moved downstream
6" Tile drains
Toes of puddle core
Present top width
Stream flow
All paving in shaded area has shifted, in some places movement of 4' down the slope
Scale
0 100 200 300

SKETCH IN PLAN OUTLINING PARTS THAT MOVED

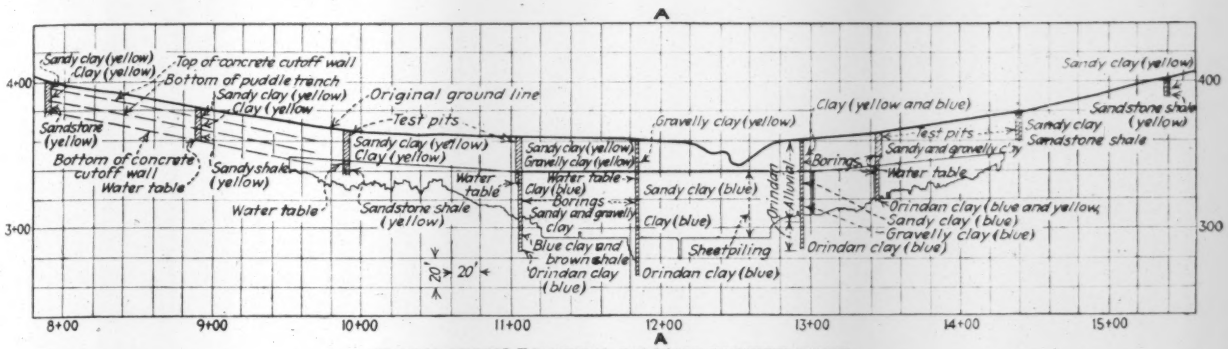


CONSTRUCTION VIEW, DOWNSTREAM FACE, BEFORE SUBSIDENCE

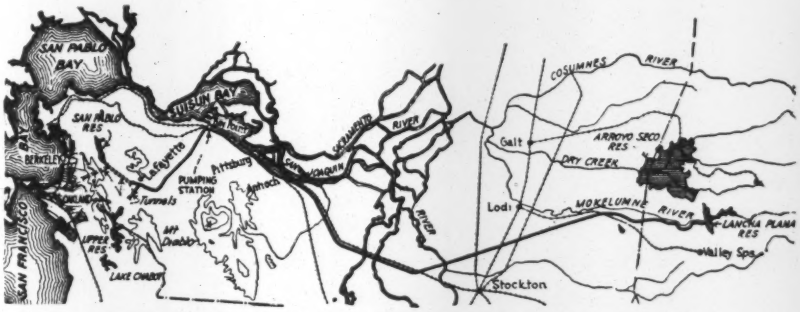
Note location of berm at right and compare with views after subsidence. Dark areas caused by sprinkling of seeded slope. Dark lines are sprinkling hose.

the slope in the central portion have buckled and spalled or have slipped under one another as much as 6 to 8 in., while toward the ends of the dam the movement has tended to open the joints. On the whole the upstream face gives decided evidence of settling but gives little if any indication of movement away from the dam center line such as occurred on the downstream side. This difference between up- and down-stream sides may be partly due to loading of the upstream toe with the weight of the pondage (whose maximum depth was about 20 ft.), together with the natural downstream slope of the streambed.

A significant point was developed by inspection of the interior of the outlet conduit under the dam. This conduit, constructed before the dam was begun, is a monolithic concrete structure of 5 ft. inside diameter, 1 ft. thick, with collars 2 ft. wide. At a point where this



FOUNDATION PROFILE ON DAM CENTER LINE



EAST BAY DISTRICT, SHOWING LOCATION OF RESERVOIR

Lafayette reservoir is being built at the west end of the pipe line from Lancha Plana reservoir near the town of Lafayette.

conduit is in the deepest part of a cut made through Orindan formation to receive it, and under a portion of the dam that apparently has not moved, the conduit has separated near one of the collars, a crack of 1½ in. wide having opened entirely around the circumference. The reinforcing steel in the conduit was pulled apart in this crack. The fact that the edges are still in alignment indicates that there was little if any lateral stress involved in the rupture.

Construction of the Lafayette dam was being done by the George Pollock Company, contract price $1,370,685. Construction began in July, 1927, and has been pushed ahead rapidly. The work has been done for the East Bay Municipal Utility District, A. P. Davis, chief engineer. George D. Louderback, professor of geology at the University of California, Berkeley, Calif., is geologist for the district.

Maine Referendum Reduces Railroad Taxes

Easing of the tax burden on railways operating in the State of Maine has been made possible by a recent election, at which a referendum vote was taken on the question of changing the system of tax levies on railroad property. Under the old system the state tax was arbitrarily set at 5 per cent of the gross transportation receipts, without regard to operating expenses. The proposed new system provides a sliding scale to be determined by the relation of gross receipts to net earning of the individual roads.

Water-Works Men Gather at Montreal Convention

Large Attendance at 47th Meeting of the New England Water Works Association

AS ANTICIPATED, there was a large attendance at the Montreal convention of the New England Water Works Association, Sept. 18 to 21. The total registration was more than 600. This included about 70 members of the American Water Works Association, some of whom were unable or unwilling to journey across the continent to the San Francisco convention of their own association last June and decided to join in the N.E.W.W. convention instead.

Papers and committee reports on a variety of subjects, together with discussions at the three sessions assigned to waterworks superintendents, are summarized on p. 475 of this issue.

The letter ballot showed the election as president of Arthur D. Weston, division engineer in charge of water supplies, Massachusetts Department of Health, Boston. Mr. Weston, in his capacity of vice-president, had served as president since the death of George A. Carpenter, of Pawtucket, soon after his election for president a year ago. Reporting as secretary, Frank J. Gifford, superintendent of the Dedham Water Company, stated that the association now has 808 members of all grades. Albert L. Sawyer, treasurer, reported a balance of about $1,100 after having transferred $2,000 to the investment fund. The latter now totals $15,600. The gross cost of the quarterly *Journal* for the year, according to Prof. Gordon M. Fair, of Harvard University, editor of the *Journal*, was $6,850.

The Dexter Brackett memorial medal, awarded annually for the best paper presented to the association during the previous year, was given to Harry W. Clark, chief chemist, Massachusetts Department of Public Health, Boston, for his paper on "Effect of Pipe of Different Metals on the Quality of Water Supplies," published in the *Journal* of the association for March, 1927.

The convention voted to send greetings to Walter H. Richards, of New London, Conn., who joined the association Oct. 11, 1882, was junior editor in 1888-89 and also for the eight years ended with 1898-99, and was made an honorary member in 1920. Mr. Richards, said C. M. Saville, of Hartford, in moving the resolution, was at one time an assistant to the late John T. Fanning.

Entertainment features provided by the Water Works Manufacturers' Association included a dinner dance on Thursday and a boat trip through the Lachine Rapids on Friday afternoon; a bus trip to and a luncheon at the new Montreal filtration plant, provided by the city of Montreal; a bus trip and luncheon given by the Consolidated Pipe Company, Ltd., of Montreal, at its plant. During this visit a demonstration of the manufacture of a concrete-spun asbestos-lined water pipe was given.

Temporary Increase in Niagara Power Authorized

The Federal Power Commission has authorized the issuance of a 90-day temporary license permitting the Niagara Falls Power Company to use an additional 275 sec.-ft. of water from the Niagara River at Niagara Falls. This water was formerly used at Lockport, N. Y., and returned to Lake Ontario through Eighteen-Mile Creek. Rights to its utilization were surrendered several months ago in favor of the Niagara Falls Power Company, which sought an amendment to its license including the new increment. This has been held up by the commission pending the submission of a statement of preliminary costs. The present temporary license will permit utilization of the water pending the preparation of this statement.

Hurricane Damage to West Indies and Florida Far Exceeds Early Estimates

Overflow of Lake Okeechobee Causes Great Loss of Life—Bridges and Smaller Buildings Suffer at Palm Beach—Thousands Without Shelter in Porto Rico

FAR greater damage was done by the hurricane that swept through Porto Rico Sept. 13 and thence into Florida than was known at the time our report of last week was written. In Florida the greatest loss of life occurred in the Lake Okeechobee region, where the lake waters were blown over the levees along the southeast rim of the lake. In the coast region centering at Palm Beach, bridges and lighter buildings were severely damaged, with apparently no serious damage to the larger buildings. The loss of life in Florida is now reported approaching 2,000. Porto Rico and neighboring islands suffered much damage to crops and the light, flimsy houses occupied by a large portion of the native population.

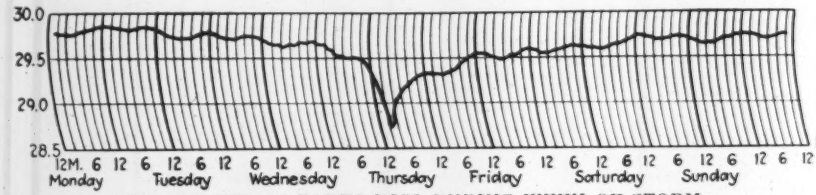
The hurricane was first reported off Leeward Islands on Sept. 11, swept to the northwest across Porto Rico and other islands of the West Indies on Sept. 13, and struck the Palm Beaches about noon Sunday, Sept. 16, the wind blowing from the northeast. At the latter point the northeast wind began with a velocity of about 70 m.p.h., which increased to a maximum of 125 to 150 m.p.h. until about 6 p.m. From 6 p.m. to about 7:30 p.m. the wind lulled to practically nothing, showing that the center of the hurricane was passing over; about 7:30 to 8 p.m. it resumed full force, with the wind from the south, the velocity again being 125 to 150 m.p.h. By 1 a.m. on Sept. 17 the wind dropped to about 60 or 70 m.p.h.

The main force of the hurricane extended from Jupiter on the north to Deerfield on the south, a distance of about 45 miles, but the outer fringe extended 125 miles, from Fort Pierce on the north to Fort Lauderdale on the south.

From Florida the storm turned north into Georgia and followed the Atlantic seaboard, with reduced violence but in the Southern states with torrential rainfall.

The situation at Lake Okeechobee is similar to that of two years ago when Moorehaven, on the west shore, was swept by the lake waters blown over the town. As seen from the accompanying map, the entire south and part of the eastern shores of the lake are confined by dikes to restrict the natural overflow into the Everglades to the south. The inflowing Kissimmee River on the north drains a large area in central Florida, a region of high annual rainfall. The St. Lucie Canal leading from the east shore is the main outlet of the lake. The other canals shown in the map are for local drainage of the swamps rather than for providing outlets for the lake. The elevation of the land to the south and east of the lake is approximately 18 ft. above sea level, with the top of the levees at El. 22. The normal lake level ranges from El. 14 to 19, depending on the season. The hurricane produced a strong west and northwest wind, piling the water up at the southeast side of the lake to such an extent that it topped the levee and railroad embankment and flooded the whole eastern Everglades area. After the first rise due to the wind the lake level again rose when the Kissimmee began to discharge its storm runoff.

Details of the damage done in the West Indies are as yet meager. In Porto Rico it is estimated that approximately half the population, or 700,000, are homeless. A large proportion of the dwellings were of flimsy construction and will be easily replaced. The main highways, mostly gravel and bituminous macadam, are undamaged. No serious bridge failures or slides have been reported. Probably the most serious losses were in the crops, especially coffee, and the destruction of many produce warehouses, factories and refineries. Conditions in the Virgin Islands are similar. Much building material is being rushed to the islands to get the stricken populace under cover. Relief has been effected throughout the devasted regions by the distribution of army and navy supplies and by work of the Red Cross.



BAROMETER IN PORTO RICO DURING WEEK OF STORM

Chart of recording barometer showing variations in barometric pressure during West Indian hurricane. Submitted by M. L. Vincente, engineer, Loiza Sugar Company, Canovanas, P. R.

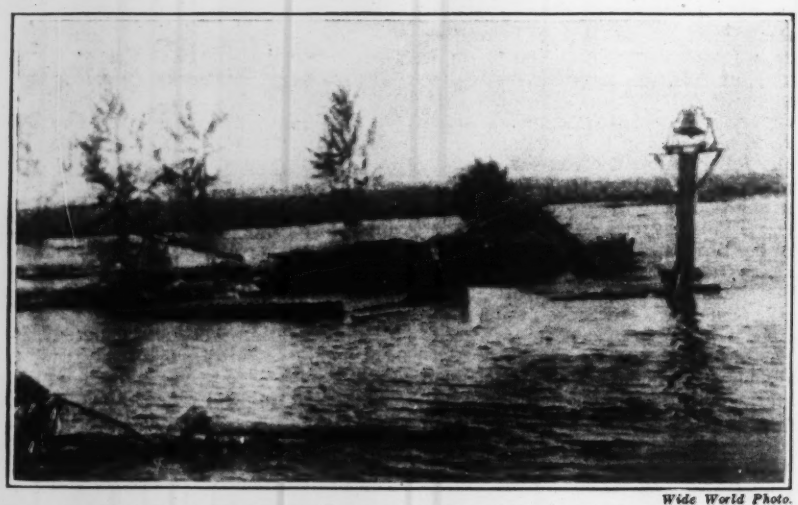
The following telegraphic reports by two engineers in the storm areas of Florida give details of the damage and the present situation in the Palm Beach and Lake Okeechobee regions:

Damage at the Palm Beaches

By Kennerley Bryan

Chief Engineer, Riddle Engineering Company, West Palm Beach, Fla.

The extent of damage to engineering structures in the immediate vicinity of the Palm Beaches consists of approximately the following: Bridge across Lake Worth from the city of Lake Worth to Palm Beach practically destroyed and should be rebuilt; this was a wooden structure on concrete piles with bascule span; approaches also washed out. Southern Boulevard bridge, West Palm Beach to Palm Beach, road approaches washed out and a small portion of decking blown off; this bridge is a wooden deck structure on wooden piling with bascule span. Royal Palm bridge, from West Palm Beach to Palm Beach, road approaches and west abutment washed out; this is a concrete arch bridge with a swing span. The damage to the approaches has been repaired and the bridge is now in use with temporary



Wide World Photo.

REMAINS OF A SCHOOLHOUSE AT CANAL POINT, FLA., DEMOLISHED BY WATER BLOWN OVER THE BANKS OF LAKE OKEECHOBEE

World Wide Photo

DEBRIS BLOWN INTO A MAIN STREET OF WEST PALM BEACH BY RECENT STORM. DEBRIS CONSISTED MOSTLY OF ROOF MATERIAL, CORNICES AND SIGNBOARDS

trestle at west abutment. None of the arches went down.

Florida East Coast Railway bridge from West Palm Beach to Palm Beach, damage very slight and repaired for use on Monday. This is a wooden pile bridge with wooden decking and swing draw span. The bridge at Lantana over the Florida Coast Line canal and Lake Worth road approaches, of wooden piling and wooden deck construction, washed out, with swing span wrecked. The bridge over Florida Coast Line canal at Boynton, consisting of steel lift span, was put out of commission when two barges jammed underneath, raising the span. The South Lake Worth inlet and bridge, which were described in *Engineering News-Record* Dec. 23, 1926, p. 1030, were undamaged.

In West Palm Beach the smoke flue fell into the elevator shaft of the Harvey Building, a fourteen-story steel-frame office structure, causing slight damage; otherwise the structure is in apparently good condition, with contents of building damaged by water. The Comeau office building, a ten-story reinforced-concrete structure, is also intact except water damage due to broken glass. The First Church of Christ, Scientist, in course of construction, having reinforced-concrete structural frame and inclosed by stone and tile walls but no glazing done, was undamaged except by the blowing away of the roof, which was unfinished.

At least 95 per cent of usual run of commercial buildings and the dwellings in the hurricane zone have been damaged, with possibly 15 per cent entirely destroyed. The damage to foliage is enormous, but can be quickly restored. It is estimated that the property damage to the Palm Beaches alone will amount to $75,000,000.

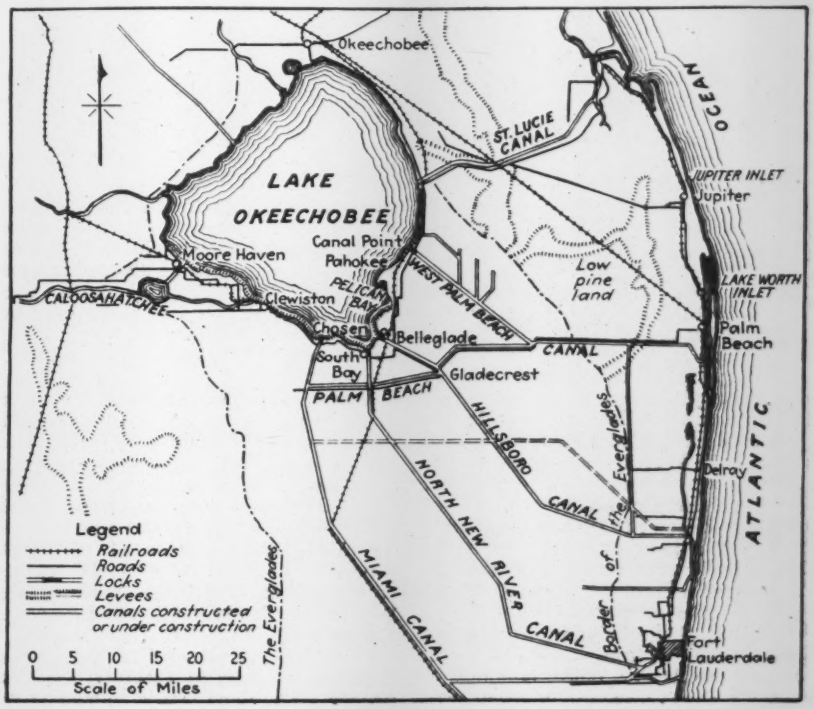
All the winter tourist hotels in Palm Beach are badly damaged by wind and water. The Breakers lost part of its roof. The ocean poured across the Palm Beach peninsula in several places into Lake Worth. The ocean boulevard from the Breakers Hotel north is destroyed and a large section from Lake Worth Casino south, a distance of about 3 miles, is also destroyed. The boulevard south of Delray to Boca Raton was destroyed in the 1926 hurricane and has never been repaired. The pier sheds at the West Palm Beach harbor opposite the north inlet are destroyed and there is some damage to the docks. It has not yet been possible to ascertain the damage to the north inlet. Before, during and after the hurricane the country was deluged with a torrent of rain, which continued practically all of Tuesday, the 18th. Many of the palatial residences of the winter colony in Palm Beach are severely damaged.

By R. S. Tilden

Engineer, Common Brick Manufacturers Association, New York City

The first and practically immediate effect of the storm was the paralyzing of practically all public services. Each of the agencies responsible for these various services had made as complete preparation as possible and as a result restoration of at least partial facilities was prompt. Railway lines suffered by both wind and high water, but the Florida East Coast Railway was fortunate in suffering little damage to roadbed or structures. Its wrecking trains found little to do other than remove poles and débris on the track and repair a few minor washouts. Signal wires were damaged seriously, however, and the system is now operated by a temporary cable laid on the ground. Other roads were not so fortunate, and up to Sept. 21 still had trouble furnishing service.

Electric current is normally brought



MAP OF LAKE OKEECHOBEE AND EVERGLADES REGION

Railroad embankment extends from point south of St. Lucie Canal on east shore south to Pahokee, there leaves the lake shore and turns south, skirting Pelican Bay to Chosen. This embankment is broken in several places. The state levee extended from Bacom Point, a peninsula extending west into Lake Okeechobee south of Pahokee, around the south shore of the bay and west along south shore of main lake to Clewiston and Moorehaven. Destruction to the levee is from the beginning to a point west of the Miami Canal.

to this district over transmission lines, and the failure of these lines forced the Florida Light & Railway Company to rely upon an emergency steam plant in West Palm Beach. It is worthy of note that this company had radioed for extra men before the storm, and this advance preparation permitted it to begin restoration of current on the 17th.

The water-works suffered its principal damage by breaks in the lines across Lake Worth. Only one line, a new 24-in. pipe, was serviceable; by the 23rd, however, the supply was approaching normal.

Telegraph lines were put completely out of service. The first move in restoration was to institute an hourly motorcycle service to Miami. More than 200 extra Western Union employees were ordered out and a special train of seventeen cars of material and personnel left Jacksonville on the 17th. The first direct wire for use was in service on the afternoon of the 19th and by late on the 21st all accumulated messages had been dispatched. Service is normal but of greatly increased volume; the number of employees in the district has been increased about ten times.

All long-distance telephone lines were out, but local service to hospitals, relief organizations and other preference-deserving agencies was prompt. Late on the 19th two lines to Jacksonville were working. Miami was reached the day following by laying cable directly on the ground. On the day of the storm most of the company employees sought protection in their headquarters building and it furnished shelter to some 2,000 refugees that night. Practically all public service organizations housed and fed their forces.

Highways in the coast region, with some exceptions, escaped serious damage. There were some washouts and at low spots water still remains, but repairs have been promptly made and most are in good condition. Sanitary conditions are good; water is being cared for, refuse removed and precautions taken to prevent disease from bodies brought in for burial, in addition to the use of inoculations for the inhabitants.

Damage to public improvements includes complete loss of city dock and casino, extensive damage to parks and municipal market, at least three bridges across Lake Worth, and damage to public buildings to varying extent. Damage to privately owned buildings is exceedingly difficult to describe in general terms, but it is accurate to say that the larger structures, well designed and constructed of reliable materials, suffered less than any other class.

The Telephone building, a structural steel building with brick walls, is intact. Damage to larger office buildings is probably slight structurally, from present information, but heavy in broken glass.

In the business district of West Palm Beach damage to glass and roofs is heavy on practically all buildings. Most smaller buildings, built of concrete block, frame and stucco or veneered, are damaged from 20 per cent to complete demolition. In the better residence districts practically all roofs, largely of tile, are seriously damaged, many residences completely demolished, and practically all damaged to a considerable extent. In the poorer district, where construction is mainly of frame or concrete block, practically every building is seriously damaged and probably 70 per cent beyond repair from an economic standpoint. In this district two churches of masonry, under construction, suffered least.

In Palm Beach residential properties suffered heavily by roof, mostly tile, damage, glass breakage, rain in interiors, washing out or blowing down of trees and landscaping, and varying structural damage. The Bath and Tennis Club is extensively damaged as to buildings, sea and inclosing walls. Garden and inclosing walls generally are extensively damaged and most cornices or roof parapets or overhangs are wrecked, practically every lamppost on Ocean Boulevard is snapped off, and there are many washouts. At some points the beach is washed out 6 or 7 ft.

It is probable that water rose about 10 ft. due to wind action. Boats in Lake Worth were thrown into streets and few if any pleasure craft on the lake escaped sinking or very extensive injury.

Damage in Lake Okeechobee Region

By Kennerley Bryan
Chief Engineer, Riddle Engineering Company, West Palm Beach, Fla.

On the afternoon of Sept. 15 the elevation of Okeechobee was 15 to 16, which is 1 to 2 ft. above normal, due to the storm of Aug. 7. The elevation of the land east and south of the lake is 17 to 18. At Pelican Bay and along the south end of the lake the elevation of the state levee was 21 to 22. The railway embankment along the east shore to Belleglade was about the same elevation. The levee, of earth, was practically destroyed, while the railway embankment, which was part filled trestle and part earthfill, was breached in several places.

Water conditions at present prevent close inspection. The flood was not caused so much by the rise in the lake due to excessive rainfall as that the wind simply blew the water out of the lake. The flood elevation from Canal Point to South Bay and a point west of the Miami Canal reached El. 26. This condition obtained around the entire east, southeast and south shores of the lake. The islands within the lake were submerged.

Practically the entire Everglades Drainage District of 1,000,000 acres is flooded. The flood waters extend 15 to 20 miles east and south of Lake Okeechobee. The death roll now exceeds 1,000 and is still growing. This Lake Okeechobee and Everglades reclamation project needs more extended engineering consideration, as the present lake control is entirely inadequate.

E. J. Mehren to Edit "Magazine of Business"

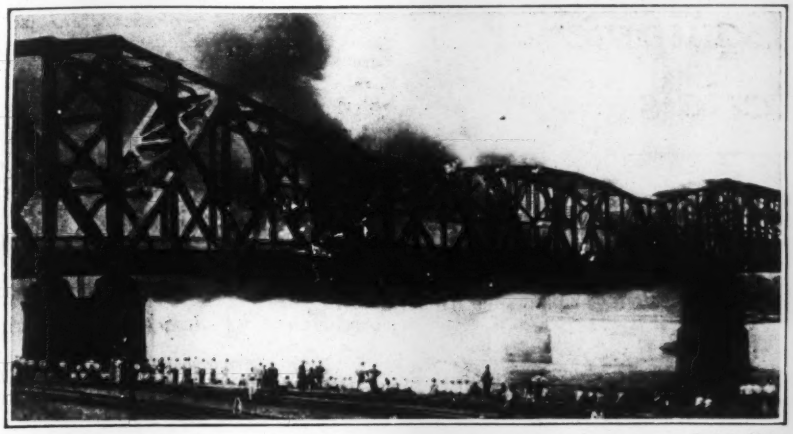
Edward J. Mehren, editor of *Engineering News-Record* until five years ago and since that time vice-president and editorial director of the McGraw-Hill Publishing Company, has been appointed editor of the *Magazine of Business*, at the same time continuing in his present duties. In his new editorial service Mr. Mehren will direct a national monthly published for business leaders and executives in the fields of finance, production, distribution and utility service.

Mr. Mehren's well-known career in technical journalism began 21 years ago, when he joined the staff of *Engineering Record* as associate editor, later becoming editor of that paper and subsequently of its successor, *Engineering News-Record*. His appointment to the editorship of a great national business magazine is further recognition of his abilities and broad experience.

Edward J. Mehren

Widely known in engineering, industry and business, Mr. Mehren has spoken and written extensively on subjects within those fields. He is the author of a series of papers on industrial conditions in Europe, based on his studies abroad and his observations at the World Economic Conference in Geneva and the meeting last year of the International Chamber of Commerce at Stockholm.

The *Magazine of Business* is published by the A. W. Shaw Company, of Chicago, which organization recently merged with the McGraw-Hill Publishing Company. It is devoted to the movements and economic factors active in modern business. Under the new editorial leadership the magazine is planned to deal intensively with the forces which assist or retard modern American business. It will be supported by a broad knowledge of business and economics, a thorough understanding of industry, an extensive acquaintanceship with business leaders and wide journalistic experience and resources.



P. & A. Photo

FIRE DESTROYING TIMBER DECKING ON HARAHAN BRIDGE AT MEMPHIS

Harahan Bridge at Memphis Damaged by Fire

Floor System and Few Truss Members Affected as Timber Decking Burns on Two Eastern Spans

FIRE on Sept. 17 destroyed the creosoted timber decking on the two eastern spans of the combined railroad and highway Harahan cantilever bridge at Memphis, damaging the steelwork of the two spans to an extent not yet fully determined. Starting in the north roadway deck shortly after noon, the fire raged for four hours, fanned by a high north wind, burning out the railroad and the two roadway decks of the long cantilever span and part of the eastern anchor span.

The bridge consists of the following spans, starting at the east or Tennessee shore: 186-ft. anchor span, 790-ft. cantilever span, 621-ft. fixed span, 186-ft. anchor span, this entire cantilever structure being of through type; and a 417-ft. deck truss span leading to the Arkansas shore. The bottom chords of all trusses are horizontal except for the deck truss, with the timber railroad and roadway decks placed 10 ft. above the bottom chords. The floor system consists of steel stringers and floorbeams carrying the double track railroad deck between the main trusses (spaced 32 ft.) and two 14-ft. highway decks outside of the trusses on cantilever brackets at the same level as the tracks.

The fire burned the entire cantilever span and well into the Tennessee anchor span as well as two panels at the east end of the long fixed span. The floorbeams, stringers and roadway brackets over the entire burned area are a total loss. The main bottom chords, four-rib members built up of eight 8x8x1-in. angles and four 42x1$\frac{5}{16}$-in. webs with top and bottom angle lacing, were damaged in three places. However, as only one of the webs of each chord was damaged, it is believed that replacement can be made without dismantling the chords.

Diagonal truss members on both the Tennessee anchor arm and the cantilever span near the first river pier were also damaged, but it has not yet been determined how much replacement will be necessary. Similar members at the west end of the cantilever span also suffered some damage.

The bridge, designed by Ralph Modjeski, was opened in 1916 and is owned by the Arkansas & Memphis Railway Bridge & Terminal Company. The railroad tracks are used jointly by the Rock Island, Missouri Pacific and the St. Louis-Southwestern railways. The roadways will be replaced by the Tennessee highway department. Contracts have already been let to the American Bridge Company for replacing the damaged steel. The Atlantic Bridge Company already has a contract for widening out the existing roadways and will replace the roadways as part of its work. The railroad tracks and one roadway are expected to be restored to service within 60 days.

Ferries supplied by the State of Tennessee are caring for highway traffic until the bridge is again in service. Trains are being routed over the single-track Frisco bridge at Memphis.

Engineering Societies

CALENDAR

Annual Meetings

NATIONAL SAFETY COUNCIL, Chicago; annual meeting, New York, N. Y., Oct. 1-5.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; fall meeting, San Diego, Calif., Oct. 3-5.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; annual convention, Toronto, Canada, Oct. 8-9.

AMERICAN WELDING SOCIETY, New York, N. Y.; fall meeting, Philadelphia, Pa., Oct. 8-12.

SOUTHWEST WATER WORKS ASSOCIATION, Fort Worth, Tex.; annual convention, Dallas, Tex., Oct. 15-18.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York, N. Y.; annual convention, Chicago, Ill., Oct. 15-19.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; annual convention, Detroit, Mich., Oct. 22-28.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION, Chicago, Ill.; annual convention, Boston, Mass., Oct. 23-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York, N. Y.; annual convention, Biloxi-Gulfport, Miss., Nov. 13-17.

Textile Publications Added to McGraw-Hill Papers

The McGraw-Hill Publishing Company, Inc., has announced the acquisition of control of the Bragdon, Lord & Nagle Company, an organization long known to the textile industry as the publisher of *Textile World*, *Textile Advance News*, the Official American Textile Directory, Consolidated Textile Catalog, American Knitting Trade Directory and a group of technical books devoted to textiles. *Textile World*, which was founded in 1863, is the oldest paper in its field. The Bragdon, Lord & Nagle organization will operate as a separate division of the McGraw-Hill Publishing Company and its management will be in the hands of its former executives. Henry G. Lord will continue as president, Frank L. Nagle as chairman of the board and H. O. Barnes as secretary. Joseph H. Bragdon will be vice-president and general manager. Mr. Lord and Mr. Bragdon become members of the board of directors of the McGraw-Hill Publishing Company and Mr. Bragdon joins its executive committee.

The addition of the textile group of papers brings the total number published by the McGraw-Hill Publishing Company and subsidiary organizations to 23, covering the fields of metal and coal mining, the electrical industry, food manufacture, industrial management, power, electric railway and bus transportation, machine tools, civil engineering and construction, radio, and chemical engineering.

Obituary

Sir HORACE DARWIN, inventor and perfecter of scientific instruments and son of Charles Darwin, author of "The Origin of the Species," died in Cambridge, England, on Sept. 23. Sir Horace, who was 77 years old, was chairman of the Cambridge Instrument Company, Ltd., and an ex-mayor of Cambridge. He was a fellow of the Royal Society and a member of the Institution of Civil Engineers.

Col. GEORGE P. HOWELL, U.S.A., retired, division engineer for the Southeast, died on Sept. 17 in the Walter Reed Hospital in Washington. Although Colonel Howell had been retired in 1922 for disability in the line of duty, he was recalled to active service in 1927, when many of the army's engineers were needed in the flooded Mississippi River states, and was assigned to Charleston, S. C., where he had previously served as division engineer.

ELBERT A. HOWARD, for twenty years county superintendent of highways of Oswego County, New York, died on Sept. 19 as the result of an infection of the leg following an automobile accident that befell early in August. He was 57 years old.

Construction Equipment and Materials

Devices for Tamping Concrete

Mechanical tamping of concrete, both by direct pressure and by hammering the forms, is provided by two types of electrically operated vibrating machines which have been tried on several construction jobs. For direct tamping, the machine (Fig. 1) consists of a motor having a weight welded upon the shaft and setting up rapid and powerful vibrations as the motor revolves at about 3,600 r.p.m. This motor, which has but the one moving part, is attached to a foot-block or tamper of desired shape and size to suit the work. The tool is carried and handled by two men by means of a spring-supported handle.

In the vibrator for compacting concrete by hammering the forms (Fig. 2), the same motor apparatus operates a tamping head. This device, which is held against the form by a handle and is operated by one man, may be slung from any convenient overhead support so that it can be moved about over the surface of the form. For circular forms, as in making concrete pipe, the device is fitted with a curved tamper (Fig. 3) and is attached to a chain which is wrapped around the form and drawn tight with a lever or binder. With this arrangement, one setting is sufficient and the vibrator is not moved around the form but is only shifted upward as the form is filled.

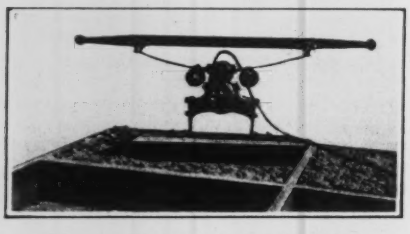


FIG. 1—ELECTRIC TAMPER ON CONCRETE

FIG. 2—TAMPER APPLIED TO FORM

With this vibratory treatment on the concrete slabs for articulated-mat bank revetment on the Mississippi (*Engineering News-Record*, March 15, 1928, p. 434), it is claimed that a material saving has been made in the amount of cement used, while maintaining the required strength. On hydro-electric plants of the Aluminum Company, the direct tamper (Fig. 1) has been used in the construction of dams, while the form-hammering device (Fig. 2) has been used in lining tunnels where the concrete was shot into place by compressed air. Tests made by the U. S. Bureau of Standards and the Portland Cement Association are said to have shown higher strength with less cement for the mechanically tamped concrete than for concrete simply poured into the forms. Some of the test specimens weighed as much as 3½ tons.

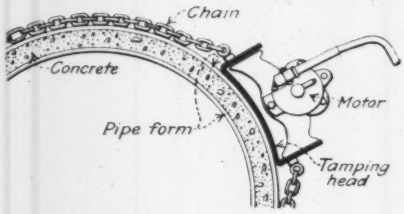


FIG. 3—TAMPER CHAINED TO CIRCULAR FORM

This process is applicable only for a fairly dry mix of concrete, no advantage being obtained by tamping or vibration on wet or sloppy concrete. The machines, developed from electric track-tamping devices, are manufactured by the Electric Tamper & Equipment Company, Chicago, Ill.

Automatic Air Dump Car in 30-Cu.Yd. Capacity

An all-steel 100,000-lb. 30-cu.yd. automatic rolling-trunnion air dump car has recently been developed by the Koppel Industrial Car & Equipment Company, a subsidiary of the Pressed Steel Car Company, Pittsburgh, Pa. The car has a length inside of body at top of 34 ft. and a width of 9 ft. 3 in. The dumping angle of the body is 45 deg.

A feature of the design is that the entire weight of the car body and lading is carried directly on the center sills without the use of trunnions. This is accomplished by rolling diaphragms built into the bolster construction located centrally on truck centers and by four rolling diaphragms, one located at each cross-bearer supporting the air cylinders. Another feature is an interlocking cast-steel stop device which prevents transverse and longitudinal movement of the body during rough handling. The dumping is controlled by three valves—the indicator valve, which shows the side on which the car is to be dumped; the operating valve, which admits air to the set of cylinders on the side for which the indicator valve is set; and the control valve, which allows the cars to be operated in trains from the operating valve of any car selected in the train.

Acid-Resisting Asbestos Roofing

A new acid-resisting corrugated asbestos roofing material is being produced by the Asbestos Shingle, Slate & Sheathing Company, Ambler, Pa. This material is made by treating corrugated asbestos roofing with an impregnating compound which protects it from acids and corrosive fumes. It is intended for use in chemical plants, smelters and similar places where corrosive fumes are encountered. The new material is made in standard sheets 42 in. wide and in lengths ranging from 4 to 8½ ft. The thickness varies from $\frac{5}{16}$ in. on the ridges and valleys to ¼ in. at the center of the slope. The corrugations are $2\frac{5}{8}$ in. from center to center. The roofing is black in color and does not absorb water or moisture.

New Truss Joists Made From Single Flange of Steel

A lightweight steel truss joist known as the Kalmantruss has been developed by the Kalman Steel Company, Chicago. The joist is made from a single piece of structural grade billet steel so that the chords and inclined web members are continuous. All joints are designed to develop the ultimate strength of the web members; the center of gravity lines of all members meet at a point. The members are of constant cross-section throughout the length of the joist, although the ends of the truss are additionally strengthened by means of vertical compression members electrically arc welded in place. The truss is manufactured by a rolling process from specially prepared blanks at a temperature of 1,800 deg. F.

The bottom chord is bent up to form the bearing end, as shown in the accompanying illustration. By this design the point of support is placed above the center of gravity of the truss, eliminating the possibility of the joist overturning when placed in position. The bearing end is in the shape of an I-beam and is made 2½ in. deep in all cases. The chords are T-shaped.

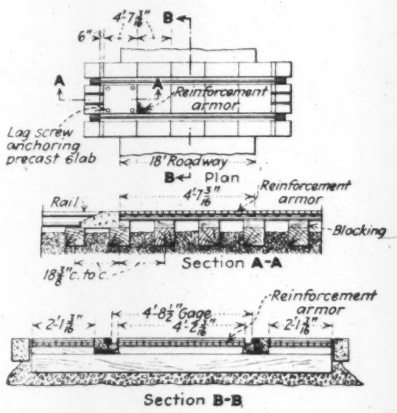
Kalmantruss Joist

Kalmantruss joists are available for clear spans from 5 ft. to 30 ft. 9 in., varying in depth from 8 in. to 16 in.;

panel lengths range from 16 to 32 in. The width of bearing varies from 1.625 in. to 2.655 in. Various accessories are available for speeding up erection and making the joist easily adaptable to a variety of conditions. Among these accessories are anchors for masonry bearing walls, anchors for structural steel supports, header angles for framing around small openings, masonry bearing plates, bridging anchors for structural steel beams and for masonry walls where the last joint parallels the beam or wall, furring rods for attaching ceiling, adjustable floor lath and ceiling lath clips and sleeper anchors for wood finish.

Reinforced and Armored Precast Slabs for Grade Crossings

An adaptation of its "Irving Unified" system of reinforcement and surface armor (described in *Engineering News-Record*, Aug. 25, 1927, p. 325) to service on railway grade crossings has been made by the Irving Iron Works, Long Island City, N. Y. The reinforcement comes in sections, each section consisting of a top and bottom panel of the company's "subway" grating united by means of shear members into a rigid steel unit, the shear members being in



the form of Warren trusses. The company recommends its use in precast concrete slabs for highway bridge crossings. An installation diagram of the precast units is shown in the accompanying illustration.

New Cable Clip Designed for Maximum Safety

A patented cable clip with two jaws fully grooved for the cable instead of only one has been developed by the Eureka Metal Products Corporation, North East, Pa. It is claimed that as a result of the design the clip carries three times the load of an ordinary clip having only one grooved jaw and U-bolt in contact with the cable. Besides this safety feature, it is claimed that the new cable clip saves cable, since there is no distortion of the cable strand. No part of the cable is gripped by the U-bolt. The clip has four parts, the same as ordinary cable clips. It is further claimed that the clips can be staggered on the cable or placed with

the U-bolts all in the same direction. These clips are made in all sizes, of steel or of bronze.

Business Notes

H. W. Bonnell has taken charge of the sales of the Northern Conveyor & Manufacturing Company, Janesville, Wis. Mr. Bonnell was formerly connected with the Fairbanks Morse Company.

National Cast Iron Pipe Company, Birmingham, Ala., announces that Paul A. Ivy has been elected vice-president. Mr. Ivy assisted in the organization of the American Cast Iron Pipe Company, and for twenty years was its general sales manager, vice-president and secretary.

Metalweld, Inc., Philadelphia, Pa., announces the appointment of the following distributors: The Prues Equipment Company, 2118 Spring Grove Ave., Cincinnati, Ohio; Lakewood Equipment Company, 1714 North Broadway, St. Louis, Mo.; G. W. Van Keppel, 2945 Main St., Kansas City, Mo.

Perfex Corporation, Milwaukee, Wis., builder of heavy-duty truck and industrial engine radiators, announces that Roger Birdsell has been elected to the directorate and made vice-president.

Paul H. Petersen, Inc., New York City, announces that it is now undertaking to provide all necessary funds to finance enterprises in foreign countries, such as co-operating with American manufacturers in selling their equipment, financing transactions on long-term credit, undertaking the complete installation and operation of entire plants of the lines which it handles. These include railway shops, wire-drawing plants, road-building machinery plants, wood- and iron-working tool plants, furnaces, hydraulic equipment plants, electric welding plants, and heating and metallurgical plants. In addition, the management of such plants will be undertaken. Paul H. Petersen has been associated for a number of years with Joseph T. Ryerson as export manager.

Equipment Corporation of America, Chicago, announces that its office has been removed to its new plant at 1150 South Washtenaw Ave. after 25 years in the Loop district. This, the 25th anniversary of the company, has witnessed the building of this new plant on the Allis-Chalmers property in Chicago, consolidation of its concrete mixer manufacturing department and plant and its subsidiary, the Marsh-Capron Company, with the Construction Machinery Company of Waterloo, Iowa, and the purchase of all the equipment owned by the James O. Heyworth Company. Recently the company also purchased the equipment used in the construction of the Conowingo dam, and, rather than move the equipment to its warehouses and plant, has established a sales office and shop at Conowingo, Md.

T. L. Smith Company, Milwaukee, announces the appointment of the J. B. Harbison Equipment Company, Little Rock, Ark., as distributor in that state. The Newlin Motor Company, the Smith distributor in Kansas City, has organized a separate department for handling the sale of contractors' equipment, which is known as the Industrial Machinery Company.

Douglas C. Corner has recently accepted the presidency of the St. Louis Power Shovel Company, builder of the Conway shovel. John L. Clarkson, formerly president of the company, is now president of the Illinois Power Shovel Company, Nashville, Ill.

Paradon Manufacturing Company, Arlington, N. J., announces the appointment of A. F. Barron, 30 North Michigan Ave., Chicago, Ill., as its sales representative in charge of the company's business in Illinois, Indiana and southern Wisconsin.

Northwest Engineering Company, Chicago, announces the appointment of L. R. Beatty, 327 South Twelfth St., Philadelphia, Pa., to cover the Philadelphia district in the interest of applying Northwest machines to industrial uses.

Manufacturers and Trade Associations

CALENDAR

Annual Meetings

CONCRETE REINFORCING STEEL INSTITUTE. Chicago; semi-annual meeting, Buckwood Inn, Shawnee-on-Delaware, Pa., October 1-3, 1928.

The Business Side of Construction

Trends in Highway Financing

In its studies of the trends in financing the nation's highways the National Industrial Conference Board finds that the basic principles employed resemble very closely those in use by public utilities, such as municipal water systems and power plants. Through the motor vehicle license charges and the gasoline taxes, a large portion of the cost of both new construction and maintenance is placed directly upon the immediate beneficiaries of the highways, and to this extent the improved road and highway system of the nation has become self-supporting. The remainder of the cost is collected as taxes from the people as a whole either through state or federal aid, which is considered a proper tax under the theory of general social benefit. The tendency during the past few years has been to make the actual users of the highways bear a greater proportion of the costs, until in 1925 almost 50 per cent of the year's current highway bill was borne by the owners of automobiles and trucks.

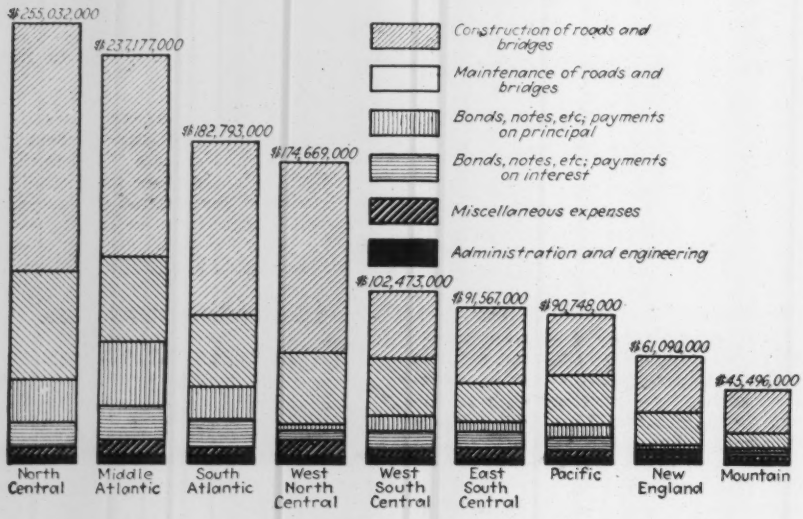
With the development of modern distribution and travel it was early seen that highway construction was an issue that transcended township and even county lines. New Jersey was the first to provide state funds for highways, making an appropriation of $75,000 for that purpose in 1892. Massachusetts followed suit the same year, and in 1895 Connecticut and California made similar provisions. Indiana, South Carolina and Texas, the last three states to take such action, did so in 1917. In 1925 this state aid reached the grand total of $623,549,000.

Direct federal aid in state highway construction did not take place till 1916, with the passage of the first federal-aid road act. These appropriations have increased until in the calendar year 1925 they totaled $92,180,406, or about 9.7 per cent of the total for the year. Federal highway aid is most important to the less prosperous states of the South and West. In 1925, while federal aid constituted only 5.5 per cent of the total road and highway revenues of New England States and 6.9 per cent of the Pacific States expenditures, the proportion for the Mountain States was 27.2 per cent and for the East South Central States 13.6 per cent.

The functional distribution of highway expenditures in 1925, as shown in the accompanying chart, is typical of annual road expenditures. Of the total expenditures of $1,241,045,000 in the nation as a whole, almost exactly one-half was spent for state roads and one-half for county and town roads, exclusive of city streets. Slightly more than one-half of the expenditures that year was for construction of new roads and bridges, and one-quarter of the expenditures was for maintenance purposes. The next item is that of the payment of principal on bonds, notes, etc., which in 1925 called for $96,634,000, or 7.8 per cent of the total road expenditures for the nation. Administration and engineering expenditures totaled only $40,703,000, or 3.3 per cent of the total. This last item varied from 2.16 per cent to 4.1 per cent of the total expenditure that was made in the various sections.

E. N.-R. Index Numbers

Cost		Volume	
Sept. 1, 1928	**207.29**	**August, 1928**	**306**
Aug. 1, 1928	207.29	July, 1928	266
Sept. 1, 1927	203.60	August 1927	306
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913.....	100.00	1913.....	100



FUNCTIONAL DISTRIBUTION OF HIGHWAY EXPENDITURE IN 1925

Near Record Volume of Contracts Awarded

The week of Sept. 18 witnessed a volume of contracts awarded for general construction projects which exceeded the previous week by 51 per cent, the corresponding week of last year by 76 per cent, and has been exceeded only four times during the present year and these by comparatively small amounts. The total for the week amounted to $92,536,000, distributed almost equally between private and public projects.

Three types of construction made significant gains over the previous week and over the same week last year. The contracts awarded for private commercial buildings totaled $35,698,000, against $19,498,000 during the week previous and $20,850,000 during the same week last year. This gain of more than 80 per cent over these previous periods was not due to one or two large contracts but was the result of a great number of large contracts of more than a million dollars, these projects being scattered throughout the nation. Contracts awarded for industrial buildings during the week totaled $7,396,000, almost three times the volume for the week previous and double that of the same week in 1927. Two large New York City subway contracts caused the unclassified volume of contracts to exceed the ten million mark.

These large construction figures would seem to contradict the opinion of economists as expressed in last week's issue that the prevailing high money rates mean that the construction industry is due for some considerable drop in volume of new projects. It is probable that the September total will be under that of recent months, but the drop, if it occurs, will not be such as to warrant the assumption that the remainder of the year will witness a material reduction in volume of new general construction.

Lumber Orders Reach Year's Record Volume

Lumber orders during the week ended Sept. 15 reached a new high for the year, according to reports to the National Lumber Manufacturers' Association from 855 softwood and hardwood mills, which recorded new business to the amount of 432,211,000 ft. In the preceding week, 842 mills reported 334,628,000 ft. for a 5-day running time.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Sept. 25, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Sept. 25, 1928	**$38,333**	**$31,408**	**$69,741**
Sept. 18, 1928	47,099	45,437	92,536
Sept. 20, 1927	36,390	38,850	75,240
Jan. 1 to Sept. 25:			
1928.....	1,061,770	1,625,946	2,687,716
1927.....	966,684	1,402,276	2,368,960